# Public Health Assessment

# Standard Chlorine Chemical Co. Inc.
## Kearny, Hudson County

CERCLIS # NJD002175057

## Public Comment Release

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*Prepared Under a Cooperative Agreement with the:*

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**
**PUBLIC HEALTH SERVICE**
**AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY**

***All comments must be submitted in writing to:***

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# THE ATSDR HEALTH ASSESSMENT: A NOTE OF EXPLANATION

**Section 104 (i) (6) (F) of the Comprehensive Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, states "...the term 'health assessment' shall include preliminary assessments of potential risks to human health posed by individual sites and facilities, based on such factors as the nature and extent of contamination, the existence of potential pathways of human exposure (including ground or surface water contamination, air emissions, and food chain contamination), the size and potential susceptibility of the community within the likely pathways of exposure, the comparison of expected human exposure levels to the short-term and long-term health effects associated with identified hazardous substances and any available recommended exposure or tolerance limits for such hazardous substances, and the comparison of existing morbidity and mortality data on diseases that may be associated with the observed levels of exposure. The Administrator of ATSDR shall use appropriate data, risk assessments, risk evaluations, and studies available from the Administrator of EPA."**

In accordance with the CERCLA section cited, this Health Assessment has been conducted using available data. Additional Health Assessments may be conducted for this site as more information becomes available.

The conclusions and recommendations presented in this Health Assessment are the result of site specific analyses and are not to be cited or quoted for other evaluations or Health Assessments.

# PUBLIC HEALTH ASSESSMENT

## STANDARD CHLORINE CHEMICAL COMPANY, INCORPORATED

## KEARNY, HUDSON COUNTY, NEW JERSEY

## EPA FACILITY ID: NJD002175057

**Prepared by:**

**New Jersey Department of Health and Senior Services**
**Consumer and Environmental Health Services**
**Under a Cooperative Agreement with the**
**U.S. Department of Health and Human Services**
**Agency for Toxic Substances and Disease Registry**

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## SUMMARY

The Standard Chlorine Chemical Company site is located at 1015 through 1035 Belleville Turnpike, Kearny, Hudson County, New Jersey. The site covers approximately 25 acres and is in an industrial area of Hudson County. Manufacturing operations were conducted at the site by various companies between 1916 and 1993 and included the refining of naphthalene, the manufacture of products from naphthalene, naphthalene derivatives and dichlorobenzenes, the formulation of drain cleaning products, and on a limited basis, the processing of trichlorobenzene during the 1970s. All operations ceased at the site in 1993.

The primary contaminants of concern at the Standard Chlorine site include polychlorinated biphenyls, chlorinated benzene compounds, naphthalene, chromium and 2,3,7,8-tetrachlorodibenzo-p-dioxin. On-site soil, sediment, surface water and groundwater contaminants migrate into the adjacent Hackensack River primarily by direct surface runoff and drainage ditches that run along the northern and southern property boundaries. Additionally, drums containing various site-related hazardous substances, including dioxin-contaminated asbestos, are consolidated into six sea boxes at the site. Based on October 2002 United States Environmental Protection Agency sampling results as well as results from previous sampling events that documented extensive on-site soil and groundwater contamination, the site was proposed to be added to the National Priorities List on April 30, 2003.

Although there are no completed human exposure pathways associated with the Standard Chlorine Company site at this time, the on-site contamination of soil, surface water, ground water and sediment is present at levels well above environmental comparison values. Migration of these contaminants into the Hackensack River has been documented by direct observation (e.g., a seep) and stated in the Administrative Consent Order issued by the New Jersey Department of Environmental Protection. There are two popular fishing locations on the banks of the river both 0.5 miles upstream and downstream from Standard Chlorine and hook and line fishing from boats takes place on the Hackensack River off the Standard Chlorine property. Despite the recommendations of the Fish Consumption Advisory, fishing and crabbing for consumption continues to occur. The Hackensack River is utilized by families for seasonal recreational activities such as kayaking, canoeing and the use of personal water crafts (i.e., jet skiing). The recreational uses of the Hackensack River are intermittent and therefore the likelihood of frequent significant exposures via ingestion of sediment/surface water pathway is unlikely. The site is potentially accessible to trespassers from the shore-bound side; however, the potential for exposure to these individuals on a routine basis is unlikely.

The New Jersey Department of Health and Senior Services, in cooperation with the Agency for Toxic Substances and Disease Registry have concluded that the Standard Chlorine Chemical company site currently represents an ***"Indeterminate Public Health Hazard"*** for the biota (consumption of marine life) pathway. Data associated with the biota pathway is not currently available and this pathway is the most significant pathway of exposure associated with the Standard Chlorine site, partly due to the possibility of repeated exposures. The likelihood of frequent, significant exposures to the contaminants of concern via trespassing and recreational uses of the river pathways is unlikely. Therefore, the Public Health Hazard Category recommended for these pathways is ***"No Apparent Public Health Hazard"***.

The Kearny Department of Health, the New Jersey Department of Environmental Protection, and the United States Environmental Protection Agency have reported no community concerns regarding the site. Based on currently available data, there were no identified completed exposure pathways associated with the site and no health outcome data for the Standard Chlorine site was evaluated at this time. In the past, the New Jersey Department of Health and Senior Services designed and conducted a screening project, named the Chromium Medical Surveillance Project, to determine potential exposures to people living and/or working near chromium waste sites in Hudson and Essex counties. The Standard Chlorine site was included as part of 78 workplaces targeted for screening services. Screening results indicated little evidence of clinically observable chromium-induced health effects. However, there was evidence of low levels of exposure to chromium among some participants living and/or working in the vicinity of chromium waste sites, including adult workers at the Standard Chlorine site (New Jersey Department of Health 1994).

Without extensive remedial action, the contaminants currently present on-site would represent a potential public health concern if conditions or land use at the site change, resulting in potential future exposures. It is recommended that groundwater (on-site and off-site) delineation be conducted to assess the transport of on-site contaminants into the Hackensack River. Additionally, it is recommended that air monitoring be implemented during remedial activities to determine the potential health impact of airborne contaminants to both on- and off-site worker populations. Hackensack River fish tissue studies are currently underway or will be initiated in July 2004 and the results when available will be reviewed by the NJDHSS, in cooperation with the ATSDR, to evaluate the contribution of site-related compounds to water and biota contamination.

## PURPOSE AND HEALTH ISSUES

On April 30, 2003, the United States Environmental Protection Agency proposed to add the Standard Chlorine Chemical Company (Standard Chlorine) site, Kearny, Hudson County, New Jersey, to the National Priorities List (NPL) of Superfund sites. The New Jersey Department of Health and Senior Services (NJDHSS), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared the following public health assessment to review environmental data obtained from the site, define potential human exposure to contaminants, and to determine whether the exposures are of public health concern.

## BACKGROUND

### A. Site History

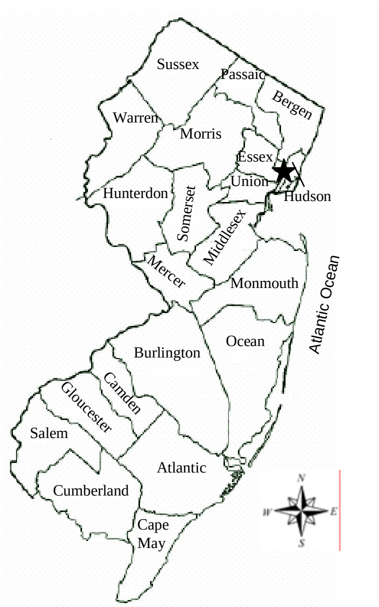


**Figure 1: Location of the Standard Chlorine Chemical Company site**

The Standard Chlorine site is approximately 25 acres in size and is located at 1015 through 1035 Belleville Turnpike, Kearny, Hudson County. The site location is shown in Figure 1. The site is bounded by the Hackensack River to the east, Belleville Turnpike to the west, and to the north by the former Diamond Shamrock site, which is currently owned by Tierra Solutions, Inc. (formerly Chemical Land Holdings, Inc.). The former Koppers Company, Inc. (Koppers) Seaboard site, currently owned by Beazer East, Inc. borders the Standard Chlorine site to the south. The site layout is shown in Appendix A, Figure 2. The Diamond Shamrock site was a chromate chemical manufacturing facility and past operations at the Koppers Seaboard site past operations included coke production, and coal-tar refining. Operations on these properties adjacent to the Standard Chlorine site were discontinued during the 1970s.

Early site history indicates that the White Tar Company refined crude naphthalene (a.k.a. white tar, moth balls, tar camphor) at the site from 1916 until 1942 when the Koppers Company acquired the site and continued similar manufacturing activities, producing naphthalene products and creosote disinfectants. Koppers also stored and packaged 1,4-dichlorobenzene moth preservatives and deodorizers in solid form at the site.

Standard Chlorine operated at the site from 1963 to 1993. Operations at the site included the manufacture of moth crystals and flakes from dichlorobenzene. Standard Chlorine also separated and stored 1,2,4-trichlorobenzene at the site from 1970 until 1980. Standard Naphthalene Products, a wholly owned subsidiary of Standard Chlorine, processed liquid petroleum naphthalene at the site from 1963 until 1982. In addition, from 1963 until 1987, Chloroben Chemical Corporation, another wholly owned subsidiary of Standard Chlorine operated a batch formulation and blending operation producing various solvents and inorganic chemicals for use in cleaning drains, sewers, and septic tanks. Some Chloroben products were formulated at the site from 1,2-dichlorobenzene. The naphthalene refining operations were conducted in the eastern two-thirds of the site. The manufacture of dichlorobenzene products and the formulations of drain cleaning products occurred in the western one-third of the site. Trichlorobenzene processing occurred in the northeastern section of the property. All operations at the site ceased in 1993. Currently, the site has no manufacturing operations and limited administrative activities are conducted in an office building located on the western end of the site.

Chromium ore processing residue (COPR) generated by three chromite ore smelting facilities located in Hudson County, was deposited in over 160 sites in Hudson and Essex Counties. The chromate waste was used as fill in preparation for building foundations, construction of tank berms, roadway construction, filling of wetlands, sewerline construction and other construction and development projects (New Jersey Department of Health 1994). Two to 10 feet of COPR underlie approximately 85 percent of the Standard Chlorine site.

The site generally consists of two distinct areas. The western two-thirds of the site contain the previous plant manufacturing activities; and the eastern third contains a lagoon system in the former processing area (see Appendix A, Figure 2). Residual waste materials are currently present within the lagoon system, which has two segments designated as the east lagoon and west lagoon. The lagoon system occupies a surface area of approximately 33,000 square feet and has an average depth of six feet. The lagoon system received process wastewaters generated from various processes at the site. Historically, the lagoon effluent has overflowed by gravity into the adjacent Hackensack River (Brown and Caldwell 2001). In 1991, measures were taken to stabilize the embankment adjacent to the river and build up the berm around the lagoon system (Weston 1993).

Aerial photographs indicate that there have been discharges to the Hackensack River from this site (Brown and Caldwell, 2001; USEPA 2003). These photographs indicate piping had existed which allowed discharge into the lagoon system. The piping appears to originate from the buildings areas directly north of the lagoon system (USEPA 2003). The lagoon system is unlined and the base of the waste material is in contact with the water table. These photographs also indicate that the above-ground product storage tanks had no secondary containment and dark toned stained soil was documented in the western end of the property as well as the processing buildings north of the lagoon system.

A NJDEP inspection of the site on August 1982 reported spillages of naphthalene and dichlorobenzenes on the ground surface at the site in several areas (USEPA 2003). In 1985, NJDEP collected and analyzed soil and sediment samples from 32 sites where compounds known to be associated with dioxin were produced as part of the Dioxin Site Investigation Program (NJDEP 1985). Standard Chlorine was included due to the usage of 1,2,4-trichlorobenzene and 1,2-dichlorobenzene at the site. This study revealed extensive 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) contamination in the lagoon system and in the former processing area north of the lagoon system, as evidenced by soil sampling and wipe samples of buildings, respectively (see Appendix A, Figure 2).

In October 1989, an Administrative Consent Order (ACO) was executed between Standard Chlorine and the NJDEP to conduct the necessary remedial investigations and perform remedial action(s). At NJDEP's direction in June 2000, Standard Chlorine performed an inventory of containerized waste materials stored in a building near the lagoon area. The inventory revealed the presence of dioxin-contaminated asbestos in approximately 400 drums and seven plastic bags. These and other drums containing waste materials from previous site investigations were consolidated into six sea boxes and remain on site. In December 2001, NJDEP terminated their ACO, indicating that Standard Chlorine had not completed remedial investigation activities and was non-compliant with the terms of the ACO. They requested that the USEPA evaluate the Standard Chlorine site as a candidate for listing on the NPL, based on complex environmental issues present at the site and the inability of the various responsible parties to implement effective remedial actions at the site. Based on results from sampling conducted by the USEPA in October 2002, as well as results from previous sampling events that documented extensive soil and groundwater contamination throughout the site, the USEPA determined that the site ranked for NPL listing. The USEPA proposed to add the Standard Chlorine site to the NPL on April 30, 2003.

The Standard Chlorine site lies in the Hackensack Meadowlands which has been identified by the United States Fish and Wildlife Service as a Significant Habitat Complex of the New York Bight Watershed at the request of the USEPA's New York/New Jersey Harbor Estuary Program, and may be a habitat for designated endangered and/or threatened species (USEPA 2003). There are also at least seven species of fish in the river that have management plans through the National Marine Fisheries Service thereby making the river Essential Fish Habitat. Additionally, of the 265 species of birds that migrate through the Meadowlands, 63 species nest in the Meadowlands and some use the river as a food source (USEPA 2003).

## B. Site Characterization

### Surface Drainage

The general direction of flow of on-site surface water is east, towards the Hackensack River. This run-off enters the Hackensack River via two outfall pipes (see Appendix A, Figure 2). Along the northern site boundary, a 48-inch diameter underground concrete stormwater pipe equipped with a tide gate receives run-off from the former Diamond Shamrock property and other commercial and industrial properties located to the west.

The eastern and western portions of the site generally slope to a central drainage swale, which receives flow from drainage ways near Buildings 2, 3 and 4 in the southwestern portion of the site (see Appendix A, Figure 2). This swale directs surface water to a drainage ditch that runs along the southern site boundary. A small drainage way along the eastern side of an abandoned railroad spur in the center of the site also drains southward into this ditch. Additionally, shallow groundwater also discharges to this southern drainage ditch. The on-site surface water in the ditch enters the Hackensack River via the south outfall, also equipped with a tide gate. A wetlands area lies south of this drainage ditch, in the former Koppers property.

The Hackensack River borders the entire eastern property boundary. It is tidally influenced and flows south to the Newark Bay. The overall direction of flow in the Hackensack River is from north to south.

**Site Geology and Hydrogeology**

Fill materials were placed in the coastal marshlands of the region to create property for industrial development. These fill materials generally consisted of COPR and silty sand, to depths ranging between two to10 feet below present grade. Underneath this fill material lies the original marsh surface, known as the Meadow Mat, consisting of silt, humus and peat. It is typically two to five feet thick. A sand layer is present beneath the Meadow Mat that is generally less than ten feet thick. A silt and clay unit is present beneath the sand layer and this layer is continuous beneath the Standard Chlorine site (Key Environmental 1997). Site characterization activities have focused on two separate groundwater-bearing units: 1) the shallow fill unit; and 2) the sand unit that underlies the Meadow Mat. The water table at the site occurs in the fill material placed above the Meadow Mat.

The groundwater flow in the fill material is primarily to the south, approximately parallel to the direction of flow in the Hackensack River. Groundwater in the fill unit in the eastern portion of the Standard Chlorine site discharges to the Hackensack River and the southern drainage ditch. Studies have indicated that the groundwater within the fill material is not tidally influenced. Groundwater in the sand unit beneath the Meadow Mat flows primarily to the south-southeast towards the drainage ditch. The underlying clay acts as an effective barrier to the downward migration of groundwater from this unit. Groundwater within the sand unit is tidally influenced to a limited extent.

## C. Demography and Land Use

The Standard Chlorine site is located in an industrial area near the New Jersey Turnpike and Belleville Turnpike. Based upon the 2000 United States Census, population demographics indicate that there are no people or housing units within a one mile radius of the site (see Appendix A, Figure 3). The site is within the New Jersey Meadowlands Commission Hackensack Meadowlands District, which has zoned the site as intermodal (see Appendix A, Figure 4). Permitted uses within this zoning are motor freight terminals, freight forwarding and intermodal facilities. The nearest residential area in Kearny is over two miles to the west.

## D. Past ATSDR/NJDHSS Involvement

From January 1992 through September 1993, the New Jersey Department of Health designed and conducted a screening project to determine potential exposure to people living and/or working near chromium waste sites in Hudson and Essex counties. This project, named the Chromium Medical Surveillance Project, included the workers at the Standard Chlorine site as part of 78 workplaces targeted for screening services. The project found evidence of exposure to adult workers at the Standard Chlorine site (New Jersey Department of Health 1994).

**E. Site visit**

On February 18, 2004 staff performed a site visit of the Standard Chlorine site. Present were Steven Miller, Julie Petix, Tariq Ahmed, Somia Aluwalia of the NJDHSS; Leah Escobar of the ATSDR; Gary Lipsius of the NJDEP; Enrique Castro of Tierra Solutions, Inc., (current owner of the former Diamond Shamrock site); Margaret Kelly of Standard Chlorine, Inc.; Gerard Coscia of Langan Engineering and Environmental Services; Mitchell Brourman of Beazer East Inc. (current owner of the former Koppers Company, Inc.); and James Zubrow of Key Environmental Inc.

The site visit commenced at 9:30 am. The weather conditions were sunny, cold with temperature in the mid 30s with a stiff breeze. As seen in Figure 2, the site is bordered to the north by the former Diamond Shamrock site; to the east by the Hackensack River; to the south by the former Koppers site; and to the west by the Belleville Turnpike. The main driveway leading to Standard Chlorine from the Belleville Turnpike is gated and this driveway runs along the entire northern boundary of the Standard Chlorine site. This driveway is common to Standard Chlorine and the former Diamond Shamrock sites. Tierra Solutions, Inc. lease their property for trailer storage and therefore the driveway is accessed by drivers transferring trailers in the former Diamond Shamrock site. The Standard Chlorine site is fenced and gated along the western perimeter and there is an old wooden guard house that was unoccupied at the time of the site visit. “No trespass” signs were observed at northeastern part of the fence that separates the lagoon system in the Standard Chlorine site from the main driveway. All buildings on the site are abandoned with the exception of an office building located on the western end of the site. Individuals present for the site visit convened in this office building to discuss major issues associated with the contaminants of concern at the site.

The site visit proceeded from this office building to an area where six sea boxes are stored, containing dioxin-contaminated asbestos and mixed organic wastes. Numerous physical hazards were present at the site including dilapidated buildings, broken windows, debris, and an open drainage ditch. Additionally, areas along the edge of the Hackensack River were littered with rubbish and debris. The site is mostly covered with asphalt, and in some sections, gravel. The asphalt and gravel caps were placed as part of interim remedial measures by the former Diamond Shamrock Company to address exposures associated with the COPR. A series of locked gates were encountered within the Standard Chlorine site. The lagoon system, located on the eastern part of the site, was visible from the Conrail right-of-way access road (Appendix A, see Figure 2). The area surrounding the lagoon system is enclosed by a six-foot high barbed wire fence. This fence is referred to as a “dust fence barrier” since it is lined with black tarp to reduce export of particles from the lagoon system area. A trench with standing water was observed inside the fenced area. The smell of naphthalene/moth balls was noted here. The southern boundary of the Standard Chlorine site was encountered which is comprised of an open drainage ditch that ultimately empties into the Hackensack River. This southern outfall into the Hackensack River was not visible from the fenced area near the lagoons. The drainage ditch had mixed standing and frozen water. *Phragmites australis* (or common reed), a wetland plant species, was observed on either side of the ditch. The former Koppers site was on the southern side of the drainage ditch and was observed to be marshy.

The Hackensack River was at low tide during the site visit. The site visit personnel proceeded to the driveway between Tierra Solutions, Inc. and Standard Chlorine and observed the north outfall into the Hackensack River from the buried storm sewer that runs along the entire northern boundary of the Standard Chlorine site. Brown green puddles, possibly indicative of chromium contaminated water, were observed on the surface of the driveway. Upwelling of the water into the driveway occurs due to the high water table, especially under wet weather conditions. Surface water, rapidly running into a sewer drain was also observed on this driveway.

A small number of Standard Chlorine personnel occasionally work in the on-site office building. When asked about vandalism, they commented that it was a problem in the past, occurring primarily at night. This was evident from the numerous broken windows observed for on-site buildings, although Standard Chlorine personnel stated that wind damage accounted for some of this damage. According to Standard Chlorine personnel, individuals from various trucking companies periodically visit the site to inquire about the sale of the property. Local discussions about possible future uses for the site included light industrial warehousing (e.g., big box storage) and commercial (e.g., Walmart, Lowe's). Recreational uses of the Hackensack River adjacent to the site were not discussed during the site visit; this was discussed separately in a telephone conversation with the Hackensack Riverkeeper, Captain Bill Sheehan.

There was a paucity of typical signs of trespassing such as graffiti, cigarette and beverage cans. It was observed that not all fences were topped with barbed wire; therefore access by a determined trespasser would be plausible. During the site visit, a truck driver parking a trailer on the former Diamond Shamrock site related an incident of an individual who had used the shoreline on that property for launching his boat and was accidentally locked in when the truck driver locked the gates following his departure. Overall, the site seemed secure from the land-bound side; any potential trespassing would be limited to older children or adults. The river-bound portion of the site is not fenced and therefore access from the Hackensack River is possible. Although trash was observed along the shore-line, it was difficult to determine if this was due to trespassers or if it was wash-up from the tidally influenced Hackensack River.

Pictures from the site visit are catalogued in Appendix B.

## F. Community Concerns

In order to gather information on community health concerns at the Standard Chlorine site, the NJDHSS spoke with the Health Officer, Kearny Department of Health (J. Sarnas, Health Officer, Kearny Department of Health, personal communication, 2004). The local health department has reported no community concerns regarding the site. The USEPA and NJDEP do not indicate any community concerns on record.

A Hudson County community group, the Interfaith Community Organization, has voiced concerns in press about the Standard Chlorine site (Jones 2004; Lane, 2004a; 2004b). Mr. Joe Morris, the project director for this organization, has expressed opinions with regard to clean-up of the site and advocates the cleaning up of the Hackensack River to be included as part of site clean-up. The community group's general concern is clean-up of sites in Hudson County that have received chromate fill in the past. The Standard Chlorine site is one of these sites, and Mr. Morris is particularly interested in chromium contamination on-site, especially with respect to air-borne chromium dust and the leaching of chromium into the Hackensack River.

The ATSDR and the NJDHSS will review and evaluate any community health concerns which may arise. The release of the public health assessment may generate interest among the public during the public comment period. A public availability session is not currently being planned at this site. A public availability session to gather community concerns and comments will be held in the future if a need is indicated.

## ENVIRONMENTAL CONTAMINATION

A compilation of environmental sample results for the Standard Chlorine site dating from July 1983 through October 2002 is provided in the following section. Media reviewed included soil, sediment, groundwater and surface water. These data were organized by the NJDHSS as on-site (Standard Chlorine) versus off-site (Hackensack River, wetland area south of Standard Chlorine property). They were further categorized into contaminant type (chromium, volatile and semi-volatile organic compounds (VOCs/SVOCs)) in the reviewed media. There was no ambient air monitoring data available for review. The environmental sample results were then compared to the environmental comparison values detailed below. Typically the most stringent comparison value is used in the screening process to identify the contaminants of concern.

The ATSDR environmental comparison values include Environmental Media Evaluation Guide (EMEG) or Reference Media Evaluation Guide (RMEG). EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-cancer health effects. When EMEGs or RMEGs were not available, the USEPA Region 3 Risk-Based Concentrations (RBCs) were used. RBCs are contaminant concentrations corresponding to a fixed level of risk (i.e., a Hazard Index of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower contaminant concentration) in water, air, biota, and soil.

Additionally, the New Jersey Non-Residential Direct Contact Soil Clean-up Criteria (NRDCSCC) is provided for contaminants in soil. They are based on human health impacts but also take into consideration environmental impacts. For contaminants in sediment, the New Jersey Guidance for Sediment Quality Evaluations is provided although they are based upon ecological rather than human health risk. For contaminants in surface water and groundwater, health-based New Jersey Surface Water Quality Standards (NJSWQS) and New Jersey Groundwater Quality Standards (NJGQS) are provided.

## On-Site Contamination

On-site is the area as defined in the site history section of this document. It includes the lagoon system and the open drainage ditch that originates in the center of the site (see Appendix A, Figure 2).

Soil Contaminants

*Chromium*

Soil data collected in 1991 indicate hexavalent chromium in the upper six inches of soil. The maximum concentration of hexavalent chromium in these samples was 270 mg/kg (see Appendix A, Table 1) which is above the RMEG (200 mg/kg). None of the samples collected below the Meadow Mat (located below two to 10 feet of COPR) contained hexavalent chromium above the detection limit. Total chromium concentrations in soil were more indicative of the known presence of chromium ore processing residue above the Meadow Mat. Total chromium concentrations exceeding 10,000 mg/kg were reported in a number of soil samples in the site fill; the highest reported concentration being 34,900 mg/kg, elevated above the RMEG and the NRDCSCC (see Appendix A, Table 1). However, none of the samples collected from below the Meadow Mat indicated elevated concentrations of total chromium; the highest reported concentration was 82 mg/kg collected at a depth of 13 feet below ground surface (Brown and Caldwell 2001).

*VOCs/SVOCs*

Surface soil samples in the former process area north of the lagoon system were collected for analysis during the remedial investigation completed by Weston (Weston 1993). The results of these analyses indicate the presence of 1,2-dichlorobenzene, 1,4-dichlorobenzene, the trichlorobenzene isomers, and naphthalene at elevated concentrations above the NRDCSCC and environmental comparison values (see Appendix A, Table 2). Concentrations of the polyaromatic hydrocarbons (PAHs) were greater than the NRDCSCC in these surface soil samples. Soil boring samples collected for VOCs/SVOCs analysis indicate that the soil contains elevated concentrations of 1,2-dichlorobenzene, 1,4-dichlorobenzene, the trichlorobenzene isomers and naphthalene above the NRDCSCC and environmental comparison values (see Appendix A, Table 3). The PAHs were similarly elevated in the soil boring samples. Elevated levels of lead and arsenic, higher than the NRDCSCC, were detected in soil borings in the western portion of the site (Weston 1993).

Soil samples collected for 2,3,7,8-TCDD analysis in 1985 indicated that dioxin was not present above the detection limit on the western portion of the site. However, concentrations of 2,3,7,8-TCDD collected from the eastern portion of the lagoon system area were elevated, with the maximum reported concentration being 0.0696 mg/kg (see Appendix A, Table 2). Dioxin samples collected within the lagoon system in 1987 indicated that dioxin was prevalent in these soils. The maximum reported 2,3,7,8-TCDD concentration in the soil within the lagoon system was 0.268 mg/kg (see Appendix A, Table 3). Both these maximum levels values exceed the environmental comparison value for TCDD ($1.9 \times 10^{-5}$ mg/kg).

Arochlor-1260, a polychlorinated biphenyl (PCB) congener, was detected at 9,300 mg/kg in concrete chips taken from the vicinity of the former transformer, in the western portion of the site. This concentration significantly exceeds the NRDCSCC of 2 mg/kg. It was found in lesser concentrations (0.12 to 0.29 mg/kg) in three soil samples collected directly beneath the concrete pavement, north of the former transformer (see Appendix A, Table 2).

Sediment Contaminants

*Chromium*

Total chromium levels were measured at detectable levels in the majority of sediment samples, collected from January 1991 through October 2002 (see Appendix A, Table 4). Total chromium was analyzed in numerous sediment samples across the site, including the drainage ditches and the lagoon system. The highest level (16,400 mg/kg) was detected in a sediment sample taken from the drain as it originates in the center of the site. Chromium, lead, arsenic, copper, mercury and zinc were elevated above the NRDCSCC and environmental comparison values (see Appendix A, Table 4).

*VOCs/SVOCs*

Sediment samples in the lagoon system area revealed the highest concentration of naphthalene (25,200,000 mg/kg) and phenols and PAHs, above the NRDCSCC (see Appendix A, Table 4). Additionally samples from the drainage ditch originating on-site had the highest levels of the dichlorobenzene isomers and trichlorobenzene, exceeding the environmental comparison values. The sample with the high PCB concentration (5,160 mg/kg) was collected near Building 2, near the former transformer pad (Weston 1993). The highest detected level of 2,3,7,8-TCDD (0.0595 mg/kg) was collected from the lagoon system area. Both these contaminants were detected at levels above the NRDCSCC and the environmental comparison values.

Surface Water Contaminants

*Chromium*

Sampling in the small drainage way along the eastern side of an abandoned railroad spur in the center of the site had the highest level of total chromium (1,240,000 μg/L). This exceeds the NJSWQS and the Maximum Contaminants Levels (MCLs). As presented in Table 5 in Appendix A, levels of mercury, lead and arsenic were also elevated above the environmental comparison values in the surface water samples.

*VOCs/SVOCs*

The maximum detected concentrations of the dichlorobenzene isomers were from a sample taken in the southern drainage ditch south of Building 2 (Weston 1993). These and other VOCs/SVOCs were present in the majority of the surface water samples, but at concentrations less than the environmental comparison values and standards (see Appendix A, Table 5). A review of the available data indicated that elevated levels of 2,3,7,8-TCDD have not been reported.

Groundwater Contaminants

*Chromium*

Since COPR is present throughout the site, levels of total chromium as well as hexavalent chromium are elevated above the NJGQS and MCLs in a majority of the monitoring wells, in both the shallow and deep zones. The highest detected hexavalent chromium (97,000 μg/L) was reported in the northeastern portion of the site. The same monitoring well had the maximum detected total chromium (101,700 μg/L). Additionally, as presented in Table 6 in Appendix A, all metals with the exception of cyanide, were also present at levels exceeding the environmental comparison values and standards in the groundwater.

*VOCs/SVOCs*

Based on the site's operational history, the VOCs/SVOCs concentrations are elevated and are generally higher in the area of the lagoon system, where process wastewaters were discharged (Brown and Caldwell 2001). With the exception of anthracene, all VOCs/SVOCs concentrations are above the various standards as summarized in Table 6 in Appendix A. Dioxin was reported at concentrations below the detection limit in monitoring wells located in the eastern portion of the site (Weston 1993).

Summary of On-Site Contaminants of Concern (COC)

The COC are those contaminants that are present at levels higher than the media-specific standards/criteria or the environmental comparison values. The COC present in on-site soil, sediment, surface water and groundwater are as follows:

| VOCs | SVOCs | | Metals |
|---|---|---|---|
| Benzene | 1,2-Dichlorobenzene | Fluoranthene | Antimony |
| Chlorobenzene | 1,3-Dichlorobenzene | Indeno(1,2,3-cd)pyrene | Arsenic |
| Methylene Chloride | 1,4-Dichlorobenzene | Phenanthrene | Chromium |
| 1,2-Trans-Dichloroethene | 1,2,3-Trichlorobenzene | Naphthalene | Copper |
| 1,1,2-Trichloroethane | 1,2,4-Trichlorobenzene | Bis(2-ethylhexyl)phthalate | Lead |
| Trichloroethylene | Acenapthene | 2-Chlorophenol | Mercury |
| Tetrachloroethylene | Acenaphthylene | 2,4-Dichlorophenol | Nickel |
| Toluene | Benzo(a)anthracene | 2,4-Dimethylphenol | Zinc |
| Vinyl chloride | Benzo(b)fluoranthene | 2-Methylphenol | |
| Xylenes | Benzo(a)pyrene | 4-Methylphenol | |
| | Benzo(g,h,i)perylene | Phenol | |
| | Chrysene | PCB – Arochlor 1260 | |
| | Fluorene | 2,3,7,8-TCDD (Dioxin) | |

## Off-Site Contamination

Off-site is defined as the Hackensack River adjacent to the site and the southern drainage ditch portion in the former Koppers property (see Appendix A, Figure 2).

Sediment and Surface Water Contaminants

Data from the analysis of sediment samples collected from the Hackensack River and the southern drainage ditch in the former Koppers property is summarized in Table 7 in Appendix A. The maximum levels of VOCs detected were below the sediment screening guidelines, the NRDCSCC and the environmental comparison values.

In the 27 samples collected from the Hackensack River by Enviro-Sciences in 2000, total chromium concentrations were generally above 1,000 mg/kg (Brown and Caldwell 2001). In the same study, hexavalent chromium was detected in three of the 27 samples ranging in concentration from 3.8 to 78.1 mg/kg (Enviro-Sciences, Inc. 2000). Each one of these positive detections was located in the riverbed at the northeast corner of the site, close to the north outfall.

The concentration of the dichlorobenzene isomers and trichlorobenzene exceeded the sediment screening guidelines but were below the NRDCSCC and the environmental comparison values. The PAHs (benzo(a)anthracene, benzo(b)fluoroanthene, benzo(a)pyrene, benzo(g,h,i)perylene) exceeded all comparison values (see Appendix A, Table 7). The maximum detected concentration of naphthalene (4,570 mg/kg) was detected in the Hackensack River close to the lagoon system area (Enviro-Sciences, Inc. 2000) and this exceeded the NRDCSCC and the environmental comparison value. Maximum detected concentrations of PCBs (0.21 mg/kg) and 2,3,7,8-TCDD (0.0000964 mg/kg) were detected above environmental comparison values, at the shoreline near the northern outfall and at the southern drainage ditch in the wetlands area of the former Koppers property, respectively (Enviro-Sciences, Inc. 2000, USEPA 2003).

Selected VOCs/SVOCs are present in the surface water samples at concentrations above the environmental comparison values and the NJSWQS (see Appendix A, Table 8).

Summary of Off-Site Contaminants of Concern (COC)

The COC present in off-site sediment and surface water are as follows:

| VOCs | SVOCs | | Metals |
|---|---|---|---|
| Benzene | 1,2-Dichlorobenzene | Benzo(g,h,i)perylene | Arsenic |
| Chlorobenzene | 1,3-Dichlorobenzene | Indeno(1,2,3-cd)pyrene | Chromium (Total) |
| | 1,4-Dichlorobenzene | Phenanthrene | Copper |
| | 1,2,4-Trichlorobenzene | Naphthalene | Lead |
| | Benzo(a)anthracene | PCB – Arochlor 1260 | Mercury |
| | Benzo(b)fluoranthene | 2,3,7,8-TCDD (Dioxin) | |
| | Benzo(a)pyrene | | |

Basic toxicological information is provided in Appendix C for some of the most prevalent COC.

## DISCUSSION

The general method for determining whether a public health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminated source to a receptor population. It is then determined whether levels of exposure due to contamination are high enough to be of public health concern. An evaluation of exposure pathways is presented in the following section.

### Pathways Analysis

An exposure pathway is the process by which an individual is exposed to contaminants from a source of contamination and consists of the following five elements:

1) source of contamination;
2) fate and transport in environmental media (e.g., air, groundwater, surface water, soil, sediment, biota);
3) point of exposure (i.e., location of potential or actual human contact with a contaminated medium);
4) route of exposure (e.g., inhalation, dermal contact/absorption, ingestion); and
5) receptor population.

ATSDR/NJDHSS classifies exposure pathways into three groups: (1) **completed pathways**, that is, those in which exposure has occurred, is occurring, or will occur; (2) **potential pathways**, that is, those in which exposure might have occurred, may be occurring, or may yet occur; and (3) **eliminated pathways**, that is, those that can be eliminated from further analysis because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified.

The following table depicts the human pathway classification for the Standard Chlorine site:

| Human Exposure Pathways Associated with the Standard Chlorine Site | | | | | |
|---|---|---|---|---|---|
| Pathway Name | Point of Exposure | Route of Exposure | Exposed Population | Time | Pathway Classification |
| Ambient Air | Standard Chlorine site | inhalation | visitors to site, trespassers, workers on neighboring properties | Past Present Future | Eliminated |
| Surface Soil | Standard Chlorine site | skin contact, inhalation, ingestion | visitors to site, trespassers, workers on neighboring properties | Past Present Future | Potential |
| Sediment | Hackensack River, on-site drainage ditch, on-site lagoons | skin contact, ingestion | trespassers, recreational users of the river | Past Present Future | Potential |
| River Water | Hackensack River, on-site drainage ditch | skin contact, ingestion | recreational uses of the river | Past Present Future | Potential |
| Groundwater | Residences, tap | skin contact, inhalation, ingestion | residents | Past Present Future | Eliminated |
| Food Chain (biota) | Hackensack River | ingestion | recreational fishing, crabbing | Past Present Future | Potential |

## Public Health Implications

### Completed pathways

Based on available information and site visit observations, there are no known completed human exposure pathways at the Standard Chlorine site. This is because the site is currently closed to entry from the land-bound side and no tissue concentrations of site-specific contaminants (chlorinated benzenes, naphthalene) in marine life in the Hackensack River are available at present. The recreational uses of the river are intermittent and therefore the likelihood of frequent significant exposures via this pathway is unlikely. Similarly, the exposures to trespassers and visitors to the site would be infrequent and would not likely result in large exposures to on-site contaminants. This pathway can be defined as plausible but infrequent at best.

## Potential pathways

*Surface soil pathway*

As described in the site visit section of this report, there were indications of trespassers/vandals at the Standard Chlorine site (e.g., broken windowpanes on buildings, evidence of rubbish/trash washed up on the Hackensack river bank). The potential for exposure to these individuals on a routine basis is unlikely and does not justify a completed exposure pathway designation. The nearest residential area is two miles to the west and it would require a determined trespasser to access the site from the Belleville Turnpike. The northern and the western portions of the Standard Chlorine site are fenced and gated; however, the eastern portion of the site adjacent to the Hackensack River is not secure against access from the river. Although it is unlikely that the public would utilize the Standard Chlorine shoreline for recreational purposes, it was noted in the site visit that this has happened in the past (example of an individual launching boat from the shoreline) and the possibility of unauthorized access to the site via the river cannot be dismissed.

*River water/sediment/seafood pathways*

Recreational activities associated with the Hackensack River (i.e., fishing, boating) may be associated with an exposure pathway linked to the Standard Chlorine site. Seasonally, activities such as canoeing, kayaking, the use of small power boats and personal water crafts (i.e., jet-skiing) occur along this stretch of the Hackensack River. Laurel Hill park located on the Kearny dike, approximately half a mile upstream (see Appendix A, Figure 5) has a free public boat launch used by as many as 100 boats a day during the summer months (Captain B. Sheehan, the Hackensack Riverkeeper, personal communication, 2004). As stated previously, recreational uses of the Hackensack River are intermittent and therefore the likelihood of frequent significant exposures via ingestion of sediment/surface water pathway is unlikely.

Due to PCB and dioxin contamination, originating in part from the Standard Chlorine site, Fish Consumption Advisories pertaining to the consumption of some fish and blue crab have been issued for the Hackensack River. There is no commercial fishing on the Hackensack River. There are small operations that gather bait fish such as banded killifish and mummichog on a sporadic basis (Captain B. Sheehan, the Hackensack Riverkeeper, personal communication, 2004; Jim Joseph, NJDEP, personal communication, 2004). While no fisheries are designated as closed, this Advisory has been issued for the Hackensack River regarding the consumption of blue crab and striped bass due to dioxin contamination; and American eel, white perch, and white catfish due to PCB contamination in the river. The Hackensack River advisory is included as part of the Newark Bay complex advisory (NJDEP 2003; USEPA 2003).

Despite the Fish Consumption Advisories, fishing for consumption regularly takes place on the Hackensack River. There are two popular fishing locations on the banks of the river both 0.5 miles upstream and downstream from Standard Chlorine site. One location is on the Kearny dike in Laurel Hill County park and the other location is near the confluence of the Penhorn Creek and the Hackensack River (see Appendix A, Figure 5 and 6). The Hackensack River has gained in popularity for recreational fishing in recent years due to the presence of more than 60 species of fish in the river. Additionally, increased ferry traffic on the Hudson River, a neighboring river in this region, has made it harder to fish in small boats (Captain B. Sheehan, Hackensack Riverkeeper, personal communication, 2004). This has made the Hackensack River the more popular choice amongst recreational anglers.

There have been two major studies conducted by the NJDEP in 1985 and 1988, examining 2,3,7,8,-TCDD contamination in marine life in New Jersey waterways and the New York Bight, respectively (NJDEP 1985-1988). These studies are part of a statewide "Routine Monitoring Program for Toxics in Fish" developed to provide current and more comprehensive data on concentrations of toxic contaminants in fish and shellfish in order to assess human health risks and thus update/recommend fish consumption advisories gather data for advisories. The NJDEP and the NJDHSS through the interagency Toxics in Biota Committee review results from these studies to set statewide fish advisories and consumption levels. Although the dioxin levels in the Hackensack River cannot be solely attributed to Standard Chlorine, the studies indicate widespread dioxin contamination in the Newark Bay (the confluence of the Passaic and Hackensack rivers).

Two studies will commence this year that will characterize the bioaccumulation of dioxins, PCBs, PAHs (including naphthalene), selected pesticides, furans and chlorinated benzene compounds in fish and crab (B. Ruppel, NJDEP, personal communication, 2004; NJDEP 2004; E. Konsevick, New Jersey Meadowlands Commission, personal communication, 2004) in the Newark Bay complex, including the Hackensack River. These studies may allow an estimation of the contribution of site-related contaminants to localized biota and therefore to estimates of exposures via ingestion of edible marine life. The results of these studies in conjunction with river sediment evaluations may enable a quantitative attribution of an exposure dose from the Standard Chlorine site.

**Migration Pathways from On-Site to Off-Site Areas**

There are three areas of particular concern with regard to migration of on-site contaminants to off-site areas (the Hackensack River and the wetlands area of the former Koppers property). These are described as follows:

Lagoon System

The lagoon system was constructed on the eastern portion of the site in the mid-1940s and the eastern end is located approximately 25 feet from the Hackensack River shoreline. The lagoon system is unlined and the base of the waste material is in contact with the water table and the sides of the depression are chromium fill, the high permeability of which disperses drainage. Residual waste materials in the lagoons consist of sludge and viscous oils associated with sludge, and residual solids. The sludge is typically black and viscous and the chemical composition of the sludge has been identified from the analyses of four sludge samples collected as part of the Weston Remedial Investigation (RI) Report. The major constituent in each of the samples was naphthalene, which accounted for between 30 and almost 99 percent of the sample content (Weston 1993). Dioxin sampling events in February and March 1987 showed that contamination of 2,3,7,8-TCDD existed throughout the vertical extent of the waste material in the lagoons and across most of the horizontal extent of the lagoons (Weston 1993; Brown and Caldwell 2001).

Because the waste lagoon system is unlined and the base of the waste is below the elevation of the shallow groundwater table, the lagoon system currently represents the principal potential source of contaminant releases at the site, considering the relatively high concentration of constituents detected in the lagoon system sludges.

South Drainage Ditch

The southern drainage ditch received flow from drainage ways near Buildings 2, 3 and 4 in the southwestern portion of the site (see Appendix A, Figure 2). The southern drainage ditch also receives flow from the shallow groundwater. Shallow groundwater flows laterally in the sand unit and discharges to the southern drainage ditch and ultimately to the Hackensack River. The sediments in the drainage ditch were observed to have a yellow-brown color forming a scum on the water surface (USEPA 2003). While it is possible that surface water and sediments in the southern drainage ditch may be impacted from contaminants from the Koppers property to the south of the site, the highest concentration of contaminants were detected in the center of the Standard Chlorine property where the ditch originates on-site. The contaminants detected in the surface water and sediment samples collected in the southern drainage ditch are all site-attributable compounds.

Under New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water Permit, Standard Chlorine was permitted to discharge septic tank overflow, boiler blow down and stormwater runoff into the southern drainage ditch. Standard Chlorine was found in violation of the Spill Compensation and Control Act and the Water Pollution Control Act as stated in the Administrative Consent Order issued by the NJDEP and signed by NJDEP and Standard Chlorine on 20 October and 18 October, 1989, respectively (NJDEP 1989). The violations were issued for the past and current discharges of hazardous substances and pollutants into the waters and onto the lands of the State of New Jersey (NJDEP 1989). Additionally, during the October 2002 USEPA sampling event, a seep was observed entering the Hackensack River from the sediment nine feet to the southeast of the outfall where the southern drainage ditch confluences with the Hackensack River. The seep was black in color with observed sediment and chemical analysis of the seep documented the presence of 1,4-dichlorobenzene (USEPA 2003).

Both of these incidents document that site related hazardous substances from the site have directly entered the Hackensack River.

Soils

Soil boring samples taken at both the western and eastern portions of the site showed elevated levels of chlorobenzene, dichlorobenzene isomers, trichlorobenzene isomers and naphthalene. This may be the result of leakage or spillage from aboveground storage tanks, or migration of contaminants from the lagoons through the soils (Environmental Resources Management 1997; Weston 1993). Additionally the Standard Chlorine site has extensive Dense

Non-Aqueous Phase Liquid (DNAPL) contamination (Key Environmental 1999). DNAPL is a liquid that is denser than water and does not dissolve or mix easily in water (it is immiscible). DNAPL contamination is problematic because of the high density of DNAPLs relative to water; thus, they will tend to migrate to considerable depths in an aquifer until reaching a low permeability zone that will retard further downward movement.

As part of a 1999 study by Key Environmental, samples collected in the eastern part of the site had a DNAPL composition of primarily dichlorobenzene isomers, naphthalene and trichlorobenzene isomers. Significant DNAPL migration appears to have occurred from Buildings 2, 3 and 4 areas to the southwestern part of the site (Key Environmental 1999). For samples collected in the vicinity of Buildings 2, 3 and 4, the DNAPL is believed to be comprised of primarily of the dichlorobenzene isomers. The DNAPL appears to have migrated along the top of clay unit to the northeast and the northwest and was also observed to be present south of the lagoon system.

DNAPLs present potential continuing sources of dissolved-phase chemical compounds to groundwater. The most significant migration pathway for groundwater within the fill/Meadow Mat unit is flow to the drainage ditch along the southern property boundary, and to the stormwater drainage pipe along the northern property boundary, ultimately draining into the Hackensack River. The primary migration pathway for groundwater in the sand unit is to the south with discharge to the Hackensack River.

Based on these presented migration pathways, it appears that the soils and free phase product in the vicinity of Building 2 are a continuing source of contamination to the Hackensack River.

**Eliminated pathways**

The groundwater ingestion pathway has been eliminated because there are no known wells used for private or public drinking water supply located within one mile of the site (Weston 1993). In addition, a well search conducted for another NPL site located less than two miles west of the Standard Chlorine site revealed no wells within four miles of that site (ATSDR 2002). No drinking water intakes are located in this portion of the Hackensack River. Hudson County’s drinking water is supplied by four different purveyors which are the Passaic Valley Water Commission, United Water Company, United Water New Jersey, and North Jersey District Water Supply Commission. The primary sources of potable water are from watersheds outside of the county, including the Oradell Reservoir in Bergen County, New Jersey, and the Wanaque Reservoir, Passaic County, New Jersey (United Water New Jersey 2002). The Town of Kearny receives its drinking water supply from the Wanaque Reservoir in Bergen County (R. Ferraioli, Hudson County Water Department, personal communication, 2004; United Water New Jersey 2002).

The ambient air pathway has been eliminated because there is currently no community receptor population within one mile of the Standard Chlorine site (see Appendix A, Figure 3). Future redevelopment of the site for non-industrial purposes may significantly modify population demographics. Due to lack of air monitoring data for the COC, it is difficult to quantify inhalation exposure, especially to adult workers in the past at the Standard Chlorine site.

**Health Outcome Data**

Based on currently available data, there were no identified completed exposure pathways associated with the site, therefore no health outcome data for the Standard Chlorine site was evaluated at this time. In the past (from January 1992 through September 1993), the NJDHSS designed and conducted a screening project to determine potential exposures to people living and/or working near chromium waste sites in Hudson and Essex counties. This project, named the Chromium Medical Surveillance Project (CMSP), included the workers at the Standard Chlorine site as part of 78 workplaces targeted for screening services. The NJDHSS designed this project determine if exposure to chromium was occurring and to provide medical evaluations to people who live and/or work on or near chromium waste sites. Most of the persons undergoing the follow-up medical examinations revealed no apparent clinical effects attributable to chromium exposure. However, for six persons, chromium was suspected to be a possible cause or contributing factor in their clinical conditions. The CMSP found little evidence of clinically observable chromium-induced health effects, but found evidence of low levels of exposure to chromium among some participants living and/or working in the vicinity of chromium waste sites, including adult workers at the Standard Chlorine site (New Jersey Department of Health 1994).

## CHILD HEALTH CONSIDERATIONS

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults (on a pound for pound basis). They also play outdoors and often bring food into contaminated areas. They are shorter than an adult, which means they breathe dust, soil, and heavy vapors closer to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Currently there are no residents living within two miles of the Standard Chlorine site. However, the Hackensack River is used seasonally for recreational activities such as fishing, crabbing, jet-skiing and inner-tubing by families. Although this does not represent a completed exposure pathway, there is potential for incidental ingestion of contaminants in surface water, biota and river sediment. It is not expected that small children would be able to gain access to the Standard Chlorine site.

## CONCLUSIONS

The Public Health Hazard Category recommended for the Standard Chlorine site is ***"Indeterminate Public Health Hazard"*** for the biota pathway. Data associated with the biota pathway is not currently available and this pathway is the most significant pathway of exposure associated with the Standard Chlorine site, partly due to the possibility of repeated exposures. There are two popular fishing locations on the banks of the river both 0.5 miles up and downstream from Standard Chlorine and hook and line fishing from boats takes place on the Hackensack River off the Standard Chlorine property. Despite the recommendations of the Fish Consumption Advisory, fishing and crabbing for consumption continues to occur. Two studies will commence this year that will characterize the bioaccumulation of dioxins, PCBs, PAHs (including naphthalene), selected pesticides, furans and chlorinated benzene compounds in fish and crab in the Newark Bay complex, including the Hackensack River. The results of these studies may enable the NJDHSS, in cooperation with the ATSDR, to evaluate the contribution of site-related compounds to water and biota contamination.

The Hackensack River is utilized by families for seasonal recreational activities such as kayaking, canoeing and the use of personal water crafts (i.e., jet skiing). The recreational uses of the Hackensack River are intermittent and therefore the likelihood of frequent significant exposures via ingestion of sediment/surface water pathway is unlikely. The site is potentially accessible to trespassers from the shore-bound side. As stated in the pathway analysis section, the potential for exposure to these individuals on a routine basis is unlikely. Overall, the likelihood of frequent, significant exposures to the contaminants of concern via the trespassers and recreational uses of the river pathways is unlikely. Therefore, the Public Health Hazard Category recommended for these pathways is ***"No Apparent Public Health Hazard"***.

There is currently no community receptor population within one mile of the Standard Chlorine site. However, future redevelopment of the site for non-industrial purposes may significantly modify population demographics. Due to lack of air monitoring data for the COC, it is difficult to determine the potential health impact of airborne contaminants to both on- and off-site worker populations

The Standard Chlorine site has complex environmental contamination such as dioxin-contaminated asbestos consolidated into sea boxes, dioxin-contaminated buildings in the former processing area north of the lagoon system, DNAPL contamination on-site which acts as a potential continuing source of dissolved-phase chemical compounds to groundwater. The on-site contamination of soil, sediment, surface water and ground water is present at levels well above environmental comparison values. The contaminants detected in the surface water and sediment samples collected in the southern drainage ditch are all site-attributable compounds. The contaminated surface and sub-surface soils on-site impact the surface water and groundwater through sediment transport in the surface and leaching of contaminants to the groundwater. The most significant migration pathway for groundwater is flow to the drainage ditch along the southern property boundary, and to the stormwater drainage pipe along the northern property boundary, ultimately draining into the Hackensack River. Another fraction of the groundwater discharges directly to the Hackensack River. Additionally, during the October 2002 USEPA sampling event, a seep was observed entering the Hackensack River from the sediment southeast of the southern outfall. Without extensive remedial action, the on-site contaminants of concern would represent a potential public health concern if conditions or land use at the site change, resulting in future exposures.

## RECOMMENDATIONS

1. The Hackensack River is likely to be impacted by surface water run-off and groundwater discharge into the river and the potential impact on biota in the river is currently being evaluated by the NJDEP. It is recommended to the USEPA to reduce migration of on-site contaminants to the Hackensack River.

2. Given that groundwater present under the Standard Chlorine site discharges to the Hackensack River, hydrogeological investigations by the USEPA and/or potential responsible party(ies) to characterize the direction and extent of contaminant migration from the site to off-site areas are recommended. This distributional data will aid in the evaluation of the contribution of the Standard Chlorine site to the overall contaminant burden currently present in the Hackensack River.

3. As discussed in the Background section of this report, there are currently no individuals residing within a one mile radius of the site. However, there are or will be remediation workers at the Standard Chlorine site and/or neighboring properties. Additionally, future redevelopment of the site for non-industrial purposes may significantly modify population demographics. As such, it is recommended that air monitoring by the appropriate environmental regulatory agency be implemented during remedial activities to determine the potential health impact of airborne contaminants to both on- and off-site worker populations.

4. As site conditions change, public health implications and the potential for completed human exposure pathways will be reevaluated and the current designated Hazard Category will be reconsidered.

## PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Standard Chlorine site contains a description of the actions to be taken by the NJDHSS and/or ATSDR at or in the vicinity of the site subsequent to the completion of this Public Health Assessment. The purpose of the PHAP is to ensure that this health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the NJDHSS and ATSDR to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by NJDHSS and ATSDR are as follows:

**Public Health Actions Taken**

1. Available environmental data and other relevant information for the Standard Chlorine site have been reviewed and evaluated to determine human exposure pathways and public health issues.

2. Despite current Fish Consumption Advisories, some individuals continue to consume the fish and crabs caught/trapped from the Hackensack River. An education and outreach effort by the NJDEP, the Department of Agriculture and the NJDHSS commenced in April 2004 (as part of Routine Monitoring Program for Toxics in Fish study) to determine the basis for non-compliance, to educate anglers and community members the importance of fish advisories and the health effects associated with eating contaminated fish (NJDEP 2004b).

**Public Health Actions Planned**

1. Hackensack River fish tissue studies are currently underway or will be initiated in July 2004. When the final report for the NJDEP study is available in October 2005, the NJDHSS, in cooperation with the ATSDR, will review the data to evaluate the contribution of site-related compounds to water and biota contamination.

2. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions, may determine the need for additional actions at this site. The ATSDR and the NJDHSS will reevaluate and expand the Public Health Action Plan (PHAP) as warranted.

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# APPENDIX A

**Table 1**
**Standard Chlorine Chemical Company - On-Site Soil Contaminants**
**Data from Chromium Sampling Events Conducted between July 1983 - January 1991**

| Metals, PCBs and Dioxin | Soil Depth (feet) | Maximum Detected Concentration (mg/kg) | NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg) | Environmental Comparison Value (mg/kg) |
|---|---|---|---|---|
| **Chromium (Total)** | **0 - 0.5** | **18,800** | 6,100* | not available |
| | **0.6 - 7** | **34,900** | | |
| | 12 - 19 | 82 | | |
| **Chromium (Hexavalent)** | **0 - 0.5** | **270** | 6,100 | 200 (RMEG†) |
| | 0.6 - 7 | 38 | | |

* Criterion based on the ingestion exposure pathway for hexavalent chromium
† Reference Media Evaluation Guide
**Contaminants of Concern are in boldface**

**Table 2**
**Standard Chlorine Chemical Company - On-Site Soil Contaminants**
**Data from Sampling Events Conducted between May 1985 - October 1998**
**Soil Depth 0 - 2 feet**

| **Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
|---|---|---|---|
| Chlorobenzene | 99.6 | 680 | 800 (EMEG*) |
| Tetrachloroethylene | 2.30 | 6 | 500 (RMEG†) |
| Methylene Chloride | 7.02 | 210 | 90 (CREG‡) |
| Trichloroethylene | 0.866 | 54 | 7.2 (RBC§) C |
| 1,2-trans-dichloroethene | 0.0765 | 1,000 | 400 (EMEG) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **1,2-Dichlorobenzene** | **6,470** | 10,000 | 5,000 (RMEG) |
| 1,3-Dichlorobenzene | 1550 | 10,000 | 31,000 (RBC) N |
| **1,4-Dichlorobenzene** | **4,840** | 10,000 | 120 (RBC) C |
| **1,2,3-Trichlorobenzene** | **0.0326** | not available | not available |
| **1,2,4-Trichlorobenzene** | **200,000** | 1,200 | 500 (RMEG) |
| Anthracene | 46.2 | 10,000 | 20,000 (EMEG) |
| Acenapthene | 219 | 10,000 | 1,000 (EMEG) |
| Benzo(a)anthracene | 1.5 | 4 | 3.9 (RBC) C |
| **Benzo(b)fluoranthene** | **65.8** | 4 | 3.9 (RBC) C |
| **Benzo(a)pyrene** | **34.1** | 0.66 | 0.1 (CREG) |
| **Benzo(g,h,i)perylene** | **31.4** | not available | not available |
| **Bis (2-Ethylhexyl) phthalate** | 220 | 210 | 50 (CREG) |
| Di-n-octyl phthalate | 190 | 10,000 | 800 (EMEG) |
| **Chrysene** | **41.9** | 40 | 390 (RBC) C |
| Fluorene | 213 | 10,000 | 800 (EMEG) |
| Fluoranthene | 121 | 10,000 | 800 (EMEG) |
| **Indeno(1,2,3-cd)pyrene** | **35.9** | 10,000 | 3.9 (RBC) C |
| **Phenanthrene** | **428** | not available | not available |
| Pyrene | 70.5 | 10,000 | 2,000 (RMEG) |
| **Naphthalene** | **2,370,000** | 4,200 | 40 (EMEG) |
| **2,3,7,8-TCDD (Dioxin)** | **0.0696** | not available | $1.9 \times 10^{-5}$ (RBC) C |
| **PCB - Arochlor 1260**** | **9,300** | 2 | 1.4 (RBC) C |

* Environmental Media Evaluation Guide
† Reference Media Evaluation Guide
‡ Cancer Risk Evaluation Guide for $1 \times 10^{-6}$ excess cancer risk
§ Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)
** sample collected is a concrete chip
**Contaminants of Concern are in boldface**

**Table 3**
**Standard Chlorine Chemical Company - On-Site Soil Contaminants**
**Data from Sampling Events Conducted between May 1985 - January 1999**
**Soil Depth > 2 feet**

| **Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
|---|---|---|---|
| Chlorobenzene | 220 | 680 | 800 (EMEG*) |
| Chloromethane | 0.180 | 1,000 | not available |
| **Tetrachloroethylene** | **16** | 6 | 500 (RMEG†) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **1,2-Dichlorobenzene** | **9,200** | 10,000 | 5,000 (RMEG) |
| 1,3-Dichlorobenzene | 1,700 | 10,000 | 31,000 (RBC‡) N |
| **1,4-Dichlorobenzene** | **1,630** | 10,000 | 120 (RBC) C |
| **1,2,3-Trichlorobenzene** | **2,140** | not available | not available |
| **1,2,4-Trichlorobenzene** | **6,540** | 1,200 | 500 (RMEG) |
| Anthracene | 90 | 10,000 | 20,000 (EMEG) |
| Acenapthene | 25 | 10,000 | 1,000 (EMEG) |
| **Benzo(a)anthracene** | **87** | 4 | 3.9 (RBC) C |
| **Benzo(b)fluoranthene** | **58** | 4 | 3.9 (RBC) C |
| **Benzo(a)pyrene** | **82** | 0.66 | 0.1 (CREG§) |
| **Benzo(g,h,i)perylene** | **53** | not available | not available |
| Bis (2-Ethylhexyl) phthalate | 9.92 | 210 | 50 (CREG) |
| Di-n-butyl phthalate | 3.06 | 10,000 | 800 (EMEG) |
| **Chrysene** | **79** | 40 | 390 (RBC) C |
| Fluorene | 33 | 10,000 | 800 (EMEG) |
| Fluoranthene | 200 | 10,000 | 800 (EMEG) |
| **Indeno(1,2,3-cd)pyrene** | **54** | 10,000 | 3.9 (RBC) C |
| **Phenanthrene** | **200** | not available | not available |
| Pyrene | 190 | 10,000 | 2,000 (RMEG) |
| **Naphthalene** | **5,750** | 4,200 | 40 (EMEG) |
| **2,3,7,8-TCDD (Dioxin)** | **0.268** | not available | $1.9 \times 10^{-5}$ (RBC) C |
| **Metals** | **Maximum Detected Concentration (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **Lead** | **647** | 600 | not available |
| **Arsenic** | **41.9** | 20 | 0.5 (CREG) |
| **Copper** | **335** | 600 | 60 (EMEG) |

* Environmental Media Evaluation Guide

† Reference Media Evaluation Guide

‡ Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)

§ Cancer Risk Evaluation Guide for $1 \times 10^{-6}$ excess cancer risk

**Contaminants of Concern are in boldface**

**Table 4**
**Standard Chlorine Chemical Company - On-Site Sediment Contaminants**
**Data from Sampling Events Conducted between January 1991 - October 2002**

| **Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
|---|---|---|---|---|
| **Benzene** | **23.4** | 0.34 | 13 | 52 (RBC*) C |
| Chlorobenzene | 250 | not available | 680 | 800 (EMEG†) |
| **Toluene** | **63.1** | 2.5 | 1,000 | 40 (EMEG) |
| Methylene Chloride | 21.5 | not available | 210 | 90 (CREG‡) |
| Ethylbenzene | 43.3 | 1.40 | 1,000 | 5,000 (RMEG§) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **1,2-Dichlorobenzene** | **5,300** | 0.035 | 10,000 | 5,000 (RMEG) |
| 1,3-Dichlorobenzene | 3,900 | not available | 10,000 | 31,000 (RBC) N |
| **1,4-Dichlorobenzene** | **6,000** | 0.11 | 10,000 | 120 (RBC) C |
| **1,2,4-Trichlorobenzene** | **2,900** | not available | 1,200 | 500 (RMEG) |
| **2,4-Dimethylphenol** | **21,900** | not available | 10,000 | 1,000 (RMEG) |
| Anthracene | 1,700 | 0.22 | 10,000 | 20,000 (EMEG) |
| **Acenapthene** | **6,070** | 0.02 | 10,000 | 1,000 (EMEG) |
| Benzo(a)anthracene | 1.1 | 0.32 | 4 | 3.9 (RBC) C |
| **Benzo(b)fluoranthene** | **44.6** | 0.24 | 4 | 3.9 (RBC) C |
| **Benzo(a)pyrene** | **37.7** | 0.37 | 0.66 | 0.1 (CREG) |
| **Benzo(g,h,i)perylene** | **36.2** | 0.17 | not available | not available |
| **Bis (2-Ethylhexyl) phthalate** | **188** | not available | 210 | 50 (CREG) |
| Chrysene | 33.6 | 0.34 | 40 | 390 (RBC) C |
| **Fluorene** | **5,150** | 0.19 | 10,000 | 800 (EMEG) |
| **Fluoranthene** | **903** | 0.75 | 10,000 | 800 (EMEG) |
| **Indeno(1,2,3-cd)pyrene** | **48.3** | 0.20 | 10,000 | 3.9 (RBC) C |
| **Naphthalene** | **25,200,000** | 0.16 | 4,200 | 40 (EMEG) |
| **Phenanthrene** | **5,320** | 0.56 | not available | not available |
| Pyrene | 663 | 0.49 | 10,000 | 2,000 (RMEG) |
| **PCB - Arochlor 1260** | **5,160** | 0.005 | 2 | $1.9 \times 10^{-5}$ (RBC) C |
| **2,3,7,8-TCDD (Dioxin)** | **0.0595** | not available | not available | 1.4 (RBC) C |
| **Metals** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **Chromium (Total)** | **16,400** | 26 | 6,100** | not available |
| **Lead** | **15,500** | 31 | 600 | not available |
| **Arsenic** | **30** | 6 | 20 | 0.5 (CREG) |
| **Copper** | **401** | 16 | 600 | 60 (EMEG) |
| **Mercury** | **25** | 0.2 | 270 | not available |
| Cyanide | 99 | not available | 21,000 | 1,000 (RMEG) |
| **Zinc** | **1,850** | 120 | 1,500 | 600 (EMEG) |

* Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)

† Environmental Media Evaluation Guide

‡ Cancer Risk Evaluation Guide for $1 \times 10^{-6}$ excess cancer risk

§ Reference Media Evaluation Guide

** Criterion based on the ingestion exposure pathway for hexavalent chromium

**Contaminants of Concern are in boldface**

**Table 5**
**Standard Chlorine Chemical Company - On-Site Surface Water Contaminants**
**Data from Sampling Events Conducted between January 1991 - October 2002**

| Volatile Organic Compounds | Maximum Detected Concentration (µg/L) | NJ Class SE-2 Surface Water Quality Standards (µg/L) | NJ Maximum Contaminant Levels (µg/L) | Environmental Comparison Value (µg/L) |
|---|---|---|---|---|
| **Benzene** | **40** | 71 | 1 | 0.6 (CREG*) |
| **Chlorobenzene** | **600** | 21,000 | not available | 200 (RMEG‡) |
| 1,2-Trans-Dichloroethene | 21 | not available | 100 | 120 (RBC) N |
| Toluene | 6 | 200,000 | 1000 | 200 (EMEG†) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (µg/L)** | **NJ Class SE-2 Surface Water Quality Standards (µg/L)** | **NJ Maximum Contaminant Levels (µg/L)** | **Environmental Comparison Value (µg/L)** |
| **1,2-Dichlorobenzene** | **2,740** | 16,500 | 600 | 270 (RBC§) N |
| **1,3-Dichlorobenzene** | **2,920** | 22,200 | 600 | 180 (RBC) N |
| **1,4-Dichlorobenzene** | **4,680** | 3,159 | 75 | 0.47 (RBC) C |
| **1,2,4-Trichlorobenzene** | **82** | 113 | 9 | 7.2 (RBC) N |
| **2,4-Dimethylphenol** | **1,000** | not available | not available | 200 (RMEG) |
| Acenapthene | 93 | not available | not available | 370 (RBC) N |
| 2-Chlorophenol | 3.9 | 402 | not available | 30 (RBC) N |
| Phenol | 241 | 4,600,000 | not available | 3,000 (RMEG) |
| Fluorene | 2.8 | 1,340 | not available | 240 (RBC) N |
| **Naphthalene** | **270** | not available | 300 | 6.5 (RBC) N |
| **Metals** | **Maximum Detected Concentration (µg/L)** | **NJ Class SE-2 Surface Water Quality Standards (µg/L)** | **NJ Maximum Contaminant Levels (µg/L)** | **Environmental Comparison Value (µg/L)** |
| **Arsenic** | **10** | 0.136 | 10 | 0.02 (CREG) |
| **Chromium (Total)** | **1,240,000** | 3,230 | 100 | not available |
| **Copper** | **173,000** | 7.9 | 1,300 | 300 (EMEG) |
| **Lead** | **136,000** | 210 | 15 | not available |
| **Mercury** | **19,400** | 0.146 | 2 | not available |
| **Nickel** | **982,000** | 3,900 | no MCL monitoring req. | 200 (RMEG) |
| **Zinc** | **487,000** | not available | 5000 | 2,000 (EMEG) |

* Cancer Risk Evaluation Guide for 1 x $10^{-6}$ excess cancer risk

† Environmental Media Evaluation Guide

‡ Reference Media Evaluation Guide

§ Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)

**Contaminants of Concern are in boldface**

**Table 6**
**Standard Chlorine Chemical Company - Groundwater Contaminants**
**Data from Sampling Events Conducted between August 1983 - February 1999**

| Volatile Organic Compounds | Maximum Detected Concentration (µg/L) | NJ Groundwater Quality Standards (µg/L) | NJ Maximum Contaminant Levels (µg/L) | Environmental Comparison Value (µg/L) |
|---|---|---|---|---|
| **Chlorobenzene** | **93,000** | 4 | not available | 200 (RMEG[*]) |
| **1,2-Trans-Dichloroethene** | **244** | 100 | 100 | 120 (RBC[†]) N |
| **1,1,2-Trichloroethane** | **30** | not available | 3 | 0.19 (RBC) C |
| **Trichloroethylene** | **13,960** | 1 | 1 | 0.026 (RBC) C |
| **Tetrachloroethylene** | **5,350** | 1 | 1 | 0.53 (RBC) C |
| **Methylene chloride** | **415** | 2 | 3 | 4.1 (RBC) C |
| Ethylbenzene | 310 | 0.7 | 700 | 1,000 (RMEG) |
| **Vinyl chloride** | **669** | 5 | 2 | 0.015 (RBC) C |
| **Xylenes** | **1,550** | not available | 1,000 | 210 (RBC) N |
| **Toluene** | **1,290** | 1,000 | 1,000 | 200 (EMEG[‡]) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (µg/L)** | **NJ Groundwater Quality Standards (µg/L)** | **NJ Maximum Contaminant Levels (µg/L)** | **Environmental Comparison Value (µg/L)** |
| **1,2-Dichlorobenzene** | **33,000** | 600 | 600 | 270 (RBC) N |
| **1,3-Dichlorobenzene** | **26,900** | 600 | 600 | 180 (RBC) N |
| **1,4-Dichlorobenzene** | **33,000** | 75 | 75 | 0.47 (RBC) C |
| **1,2,4-Trichlorobenzene** | **26,000** | 900 | 9 | 7.2 (RBC) N |
| **2,4-Dimethylphenol** | **38,000** | 100 | not available | 200 (RMEG) |
| **Acenapthene** | **4,300** | 400 | not available | 370 (RBC) N |
| **Acenaphthylene** | **96** | 10 | not available | not available |
| **2-Chlorophenol** | **63** | 40 | not available | 30 (RBC) N |
| **Phenol** | **360,000** | 4,000 | not available | 3,000 (RMEG) |
| **2-Methylphenol** | **58,000** | not available | not available | 1,800 (RBC) N |
| **2,4-Dichlorophenol** | **321** | 20 | not available | 30 (EMEG) |
| **4-Methylphenol** | **200,000** | not available | not available | 180 (RBC) N |
| **Bis (2-Ethylhexyl) phthalate** | **11,100** | 30 | 6 | 3 (CREG[§]) |
| **Fluorene** | **303** | 300 | not available | 240 (RBC) N |
| **Phenanthrene** | **216** | 10 | not available | not available |
| Anthracene | 69 | 2,000 | not available | 1,800 (RBC) N |
| **Naphthalene** | **58,200** | not available | 300 | 6.5 (RBC) N |
| **Metals** | **Maximum Detected Concentration (µg/L)** | **NJ Groundwater Quality Standards (µg/L)** | **NJ Maximum Contaminant Levels (µg/L)** | **Environmental Comparison Value (µg/L)** |
| **Arsenic** | **130** | 0.02 | 10 | 0.02 (CREG) |
| **Antimony** | **390** | 2 | 6 | 4 (RMEG) |
| **Chromium (Total)** | **101,700** | 100 | 100 | not available |
| **Chromium (Hexavalent)** | **97,000** | not available | not available | 30 (RMEG) |
| **Copper** | **350** | 1,000 | 1,300 | 300 (EMEG) |
| Cyanide | 197 | 200 | 200 | 200 (RMEG) |
| **Lead** | **44,900** | 5 | 15 | not available |
| **Mercury** | **142** | 2 | 2 | not available |
| **Nickel** | **6,740** | 100 | no MCL monitoring req. | 200 (RMEG) |
| **Zinc** | **11,900** | 5,000 | 5,000 | 2,000 (EMEG) |

[*] Reference Media Evaluation Guide
[†] Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)
[‡] Environmental Media Evaluation Guide
[§] Cancer Risk Evaluation Guide for 1 x $10^{-6}$ excess cancer risk
**Contaminants of Concern are in boldface**

**Table 7**
**Standard Chlorine Chemical Company - Off Site Sediment Contaminants**
**Data from Sampling Events Conducted between January 1991 - October 2002**

| **Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
|---|---|---|---|---|
| Benzene | 0.41 | 0.34 | 13 | 52 (RBC*) C |
| Chlorobenzene | 120 | not available | 680 | 800 (EMEG†) |
| Toluene | 0.02 | 2.5 | 1,000 | 40 (EMEG) |
| Methylene Chloride | 0.0087 | not available | 210 | 90 (CREG‡) |
| Xylenes | 0.16 | >0.12 | 1,000 | 400 (EMEG) |
| Ethylbenzene | 0.73 | 1.40 | 1,000 | 5,000 (RMEG§) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| 1,2-Dichlorobenzene | 280 | 0.035 | 10,000 | 5,000 (RMEG) |
| 1,3-Dichlorobenzene | 290 | not available | 10,000 | 31,000 (RBC) N |
| **1,4-Dichlorobenzene** | **360** | 0.11 | 10,000 | 120 (RBC) C |
| **1,2,4-Trichlorobenzene** | **1,200** | not available | 1,200 | 500 (RMEG) |
| Anthracene | 21 | 0.22 | 10,000 | 20,000 (EMEG) |
| Acenapthene | 7.1 | 0.02 | 10,000 | 1,000 (EMEG) |
| **Benzo(a)anthracene** | **26** | 0.32 | 4 | 3.9 (RBC) C |
| **Benzo(b)fluoranthene** | **19** | 0.24 | 4 | 3.9 (RBC) C |
| **Benzo(a)pyrene** | **17** | 0.37 | 0.66 | 0.1 (CREG) |
| **Benzo(g,h,i)perylene** | **4.90** | 0.17 | not available | not available |
| Bis (2-Ethylhexyl) phthalate | 15 | not available | 210 | 50 (CREG) |
| Chrysene | 8 | 0.34 | 40 | 390 (RBC) C |
| Fluorene | 4.2 | 0.19 | 10,000 | 800 (EMEG) |
| Fluoranthene | 35 | 0.75 | 10,000 | 800 (EMEG) |
| **Indeno(1,2,3-cd)pyrene** | **56** | 0.20 | 10,000 | 3.9 (RBC) C |
| **Naphthalene** | **4,570** | 0.16 | 4,200 | 40 (EMEG) |
| **Phenanthrene** | **43** | 0.56 | not available | not available |
| Pyrene | 46 | 0.49 | 10,000 | 2,000 (RMEG) |
| **PCB - Arochlor 1254** | **0.21** | 0.005 | 2 | 0.06 (EMEG) |
| **2,3,7,8-TCDD (Dioxin)** | **0.0000964** | not available | not available | $1.9 \times 10^{-5}$ (RBC) C |
| **Metals** | **Maximum Detected Concentration (mg/kg)** | **Freshwater Sediment Screening Guidelines (mg/kg)** | **NJ Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (mg/kg)** | **Environmental Comparison Value (mg/kg)** |
| **Chromium (Total)** | **11,700** | 26 | 6,100** | not available |
| Chromium (Hexavalent) | 73 | not available | 6,100 | 200 (RMEG) |
| **Lead** | **337** | 31 | 600 | not available |
| **Arsenic** | **105** | 6 | 20 | 0.5 (CREG) |
| **Copper** | **295** | 16 | 600 | 60 (EMEG) |
| **Mercury** | **0.650** | 0.2 | 270 | not available |
| Nickel | 308 | 16 | 2,400 | 20,000 (RBC) N |

* Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)
† Environmental Media Evaluation Guide
‡ Cancer Risk Evaluation Guide for $1 \times 10^{-6}$ excess cancer risk
§ Reference Media Evaluation Guide
** Criterion based on the ingestion exposure pathway for hexavalent chromium
**Contaminants of Concern are in boldface**

**Table 8**
**Standard Chlorine Chemical Company - Off-Site Surface Water Contaminants**
**Data from Sampling Events Conducted between August 1996 - October 2002**

| Volatile Organic Compounds | Maximum Detected Concentration (μg/L) | NJ Class SE-2 Surface Water Quality Standards (μg/L) | NJ Maximum Contaminant Levels (μg/L) | Environmental Comparison Value (μg/L) |
|---|---|---|---|---|
| **Benzene** | **23** | 71 | 1 | 0.6 (CREG*) |
| **Chlorobenzene** | **760** | 21,000 | not available | 200 (RMEG†) |
| **Semi-Volatile Organic Compounds** | **Maximum Detected Concentration (μg/L)** | **NJ Class SE-2 Surface Water Quality Standards (μg/L)** | **NJ Maximum Contaminant Levels (μg/L)** | **Environmental Comparison Value (μg/L)** |
| **1,2-Dichlorobenzene** | **6,130** | 16,500 | 600 | 270 (RBC§) N |
| **1,3-Dichlorobenzene** | **430** | 22,200 | 600 | 180 (RBC) N |
| **1,4-Dichlorobenzene** | **6,370** | 3,159 | 75 | 0.47 (RBC) C |
| **1,2,4-Trichlorobenzene** | **200** | 113 | 9 | 7.2 (RBC) N |
| **Naphthalene** | **45** | NA | 300 | 6.5 (RBC) N |
| **Metals** | **Maximum Detected Concentration (μg/L)** | **NJ Class SE-2 Surface Water Quality Standards (μg/L)** | **NJ Maximum Contaminant Levels (μg/L)** | **Environmental Comparison Value (μg/L)** |
| **Chromium (Total)** | **3,000** | 3,230 | 100 | not available |

* Cancer Risk Evaluation Guide for 1 x $10^{-6}$ excess cancer risk
† Reference Media Evaluation Guide
§ Risk Based Concentration (N: Non carcinogenic effects; C: Carcinogenic effects)
**Contaminants of Concern are in boldface**

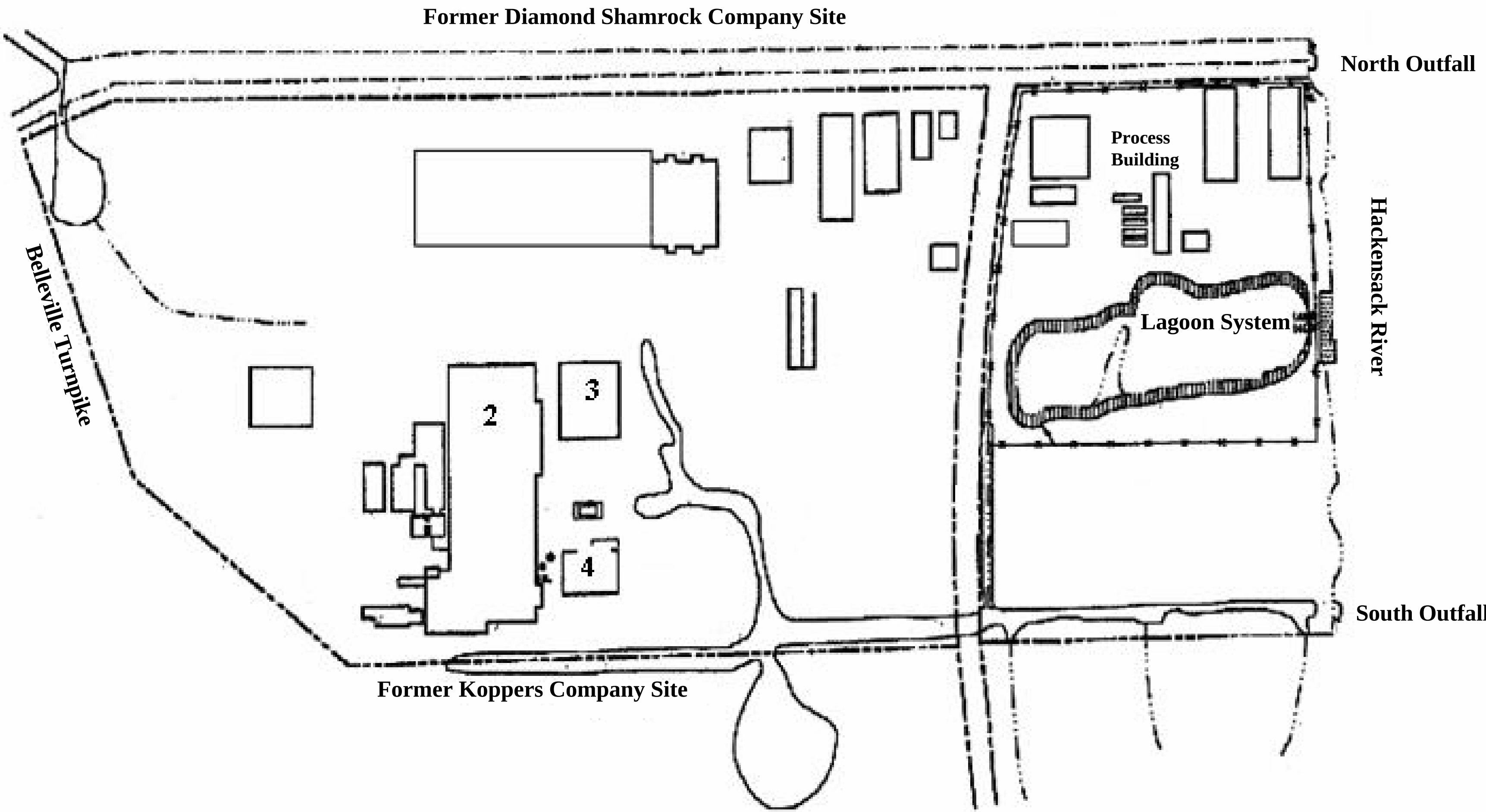
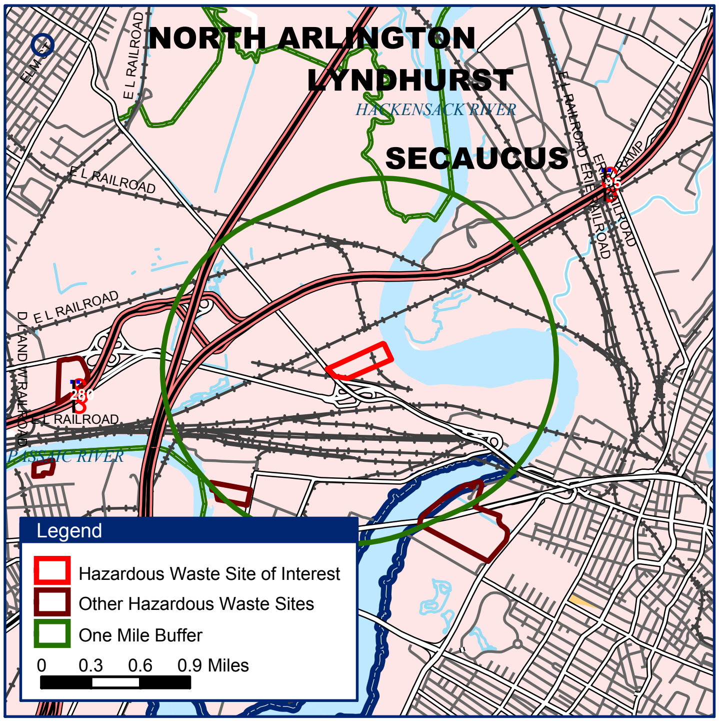



**Figure 2: Site Map of the Standard Chlorine Chemical Company**

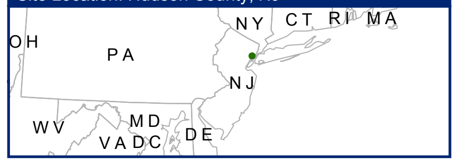
## Standard Chlorine
Kearny, NJ
EPA Facility ID: NJD002175057

ATSDR AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY | CDC




Base Map Source: Geographic Data Technology (DYNAMAP 2000), August 2002
Site Boundary Data Source: ATSDR Public Health GIS Program, August 2002
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

Site Location: Hudson County, NJ

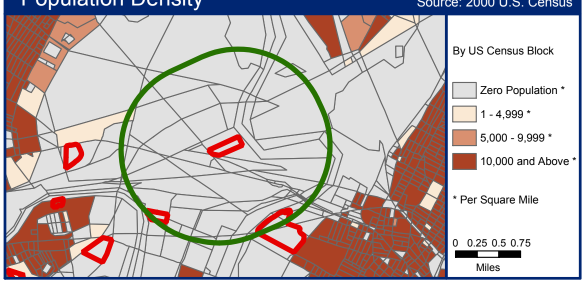



### Demographic Statistics
Within One Mile of Site*

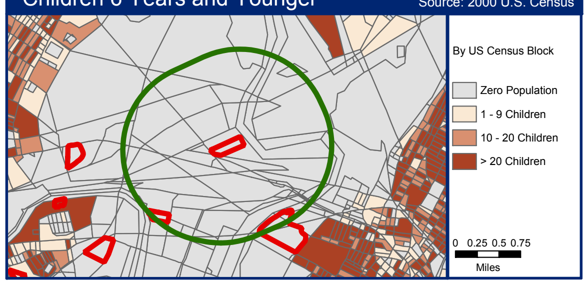
| | |
|---|---|
| Total Population | 0 |
| White Alone | 0 |
| Black Alone | 0 |
| Am. Indian & Alaska Native Alone | 0 |
| Asian Alone | 0 |
| Native Hawaiian & Other Pacific Islander Alone | 0 |
| Some Other Race Alone | 0 |
| Two or More Races | 0 |
| Hispanic or Latino** | 0 |
| Children Aged 6 and Younger | 0 |
| Adults Agend 65 and Older | 0 |
| Females Aged 15 to 44 | 0 |
| Total Housing Units | 0 |

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

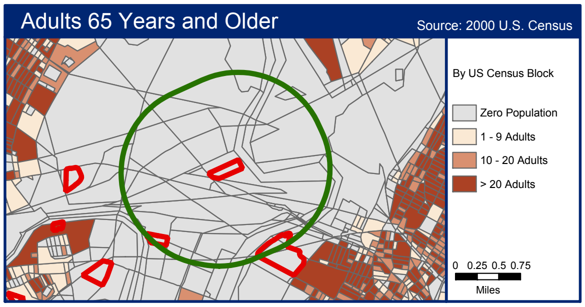
### Population Density
Source: 2000 U.S. Census



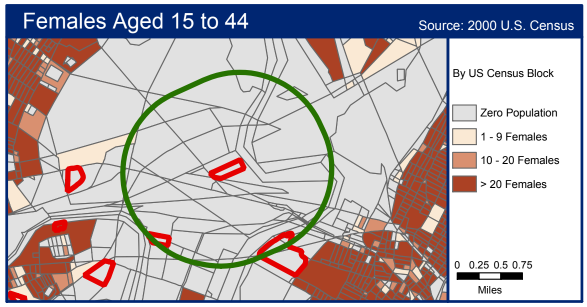

### Children 6 Years and Younger
Source: 2000 U.S. Census




### Adults 65 Years and Older
Source: 2000 U.S. Census




### Females Aged 15 to 44
Source: 2000 U.S. Census




GENERATED: 12-04-2003



**Figure 3: Demographic Information of the Standard Chlorine Site based on 2000 U.S. Census**

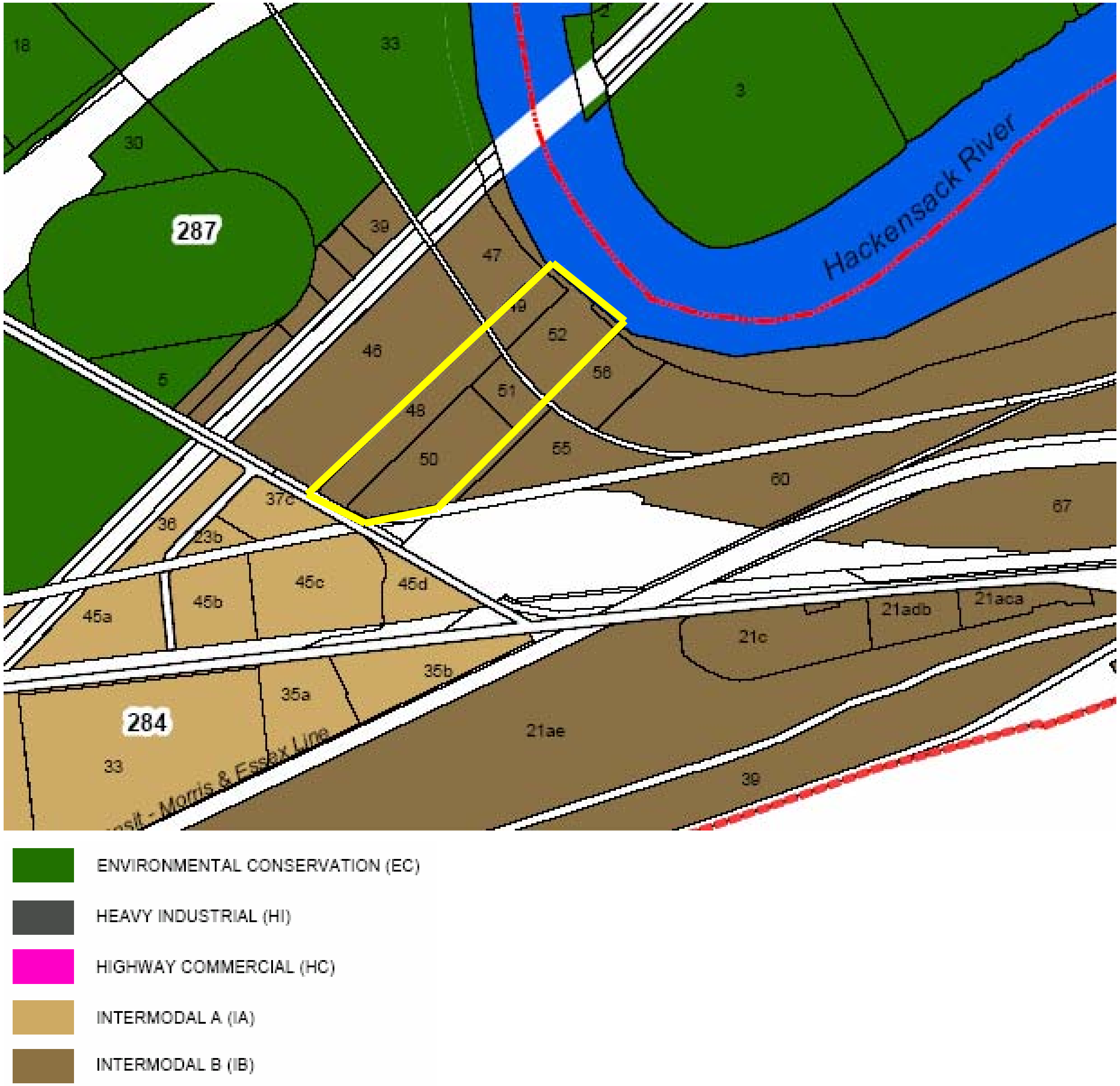



**Figure 4: The New Jersey Meadowlands Commission zoning map (yellow represents site boundaries)**

Available from: http://www.meadowlands.state.nj.us/maps/zone_2004_32X43.pdf

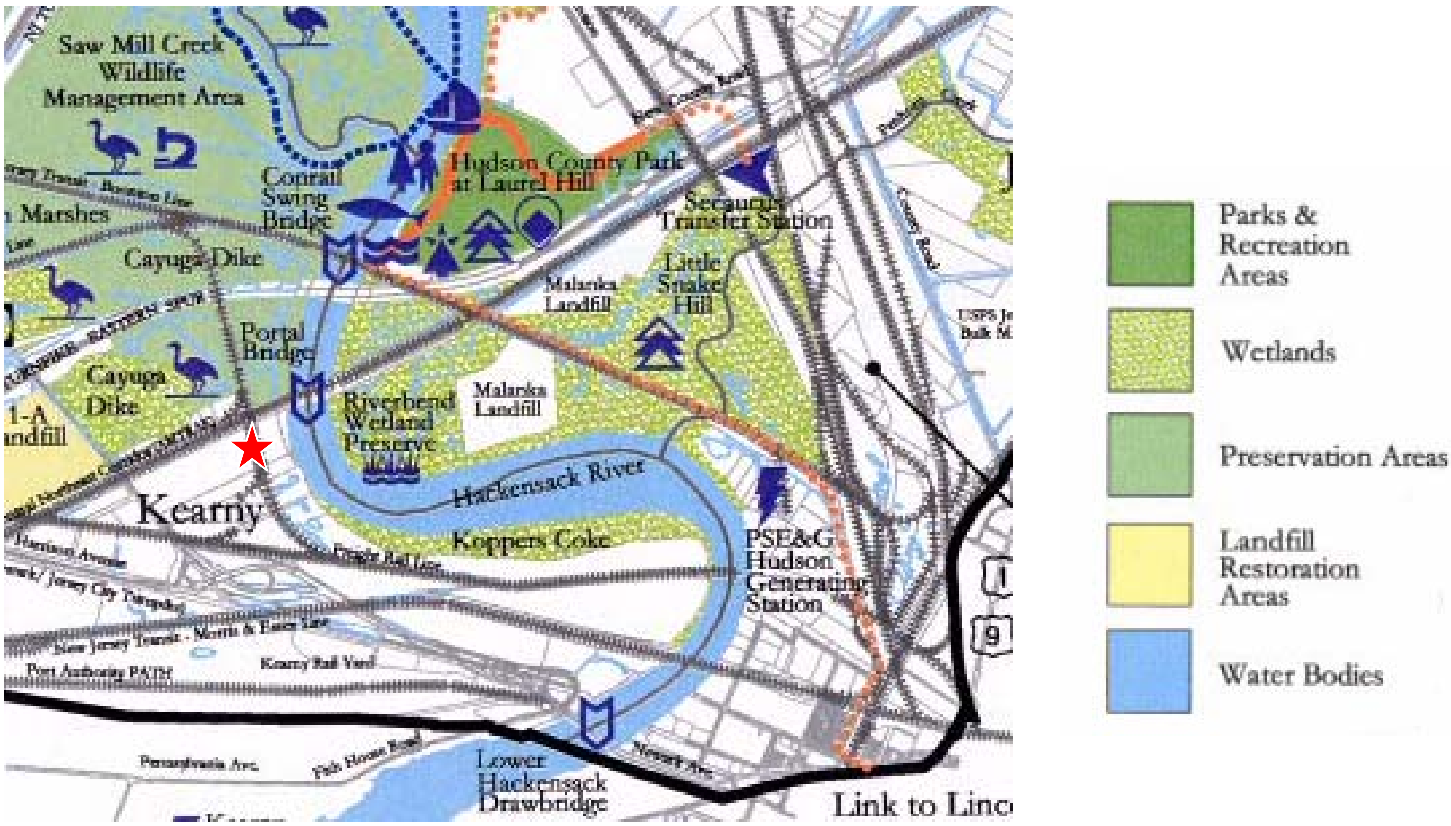



**Figure 5: Map showing recreational and conservation areas near the Standard Chlorine site (star represents the site location)**

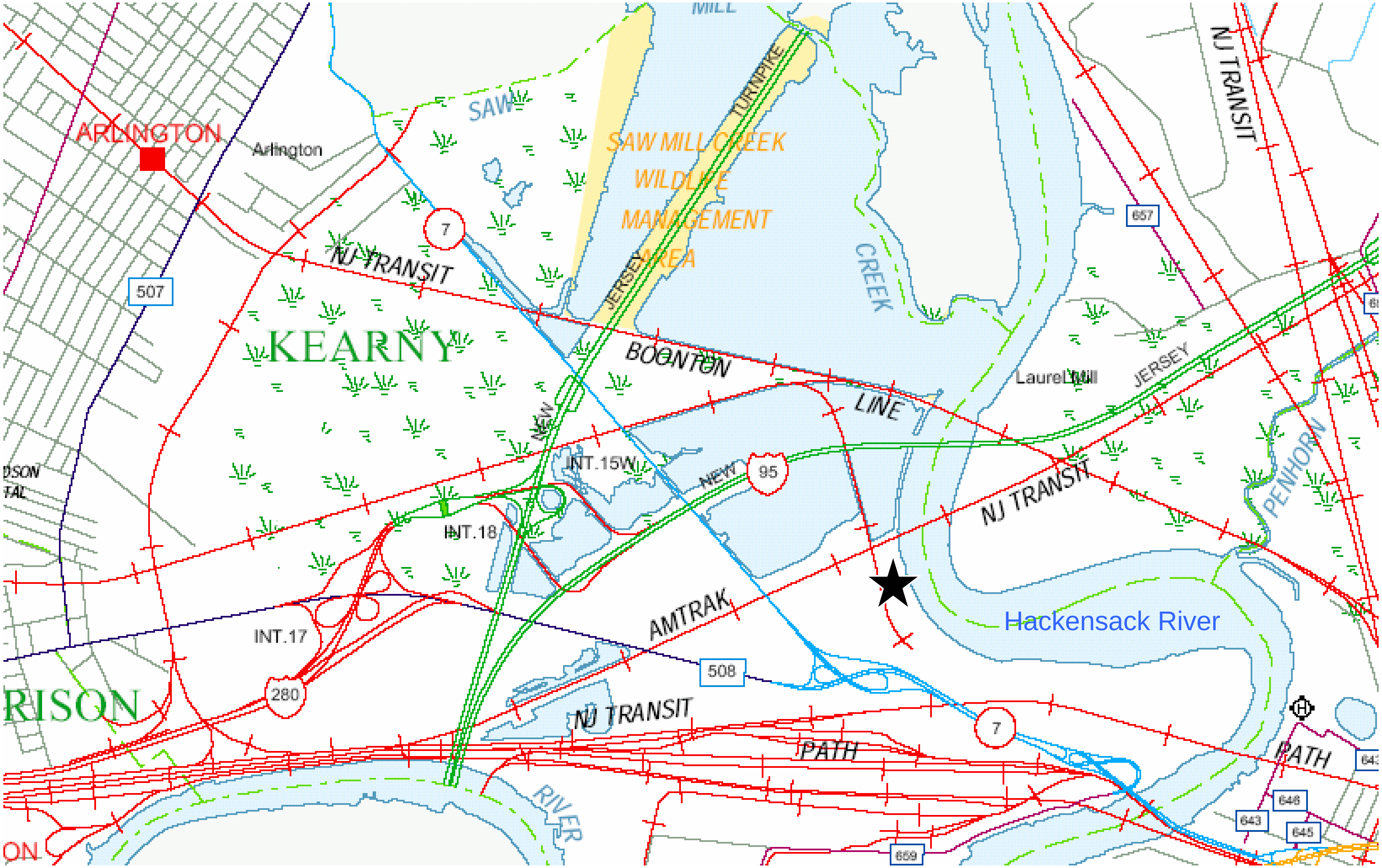



**Figure 6: Map depicting the major roadways/railway transit lines near the Standard Chlorine site (star represents the site location)**

# APPENDIX B

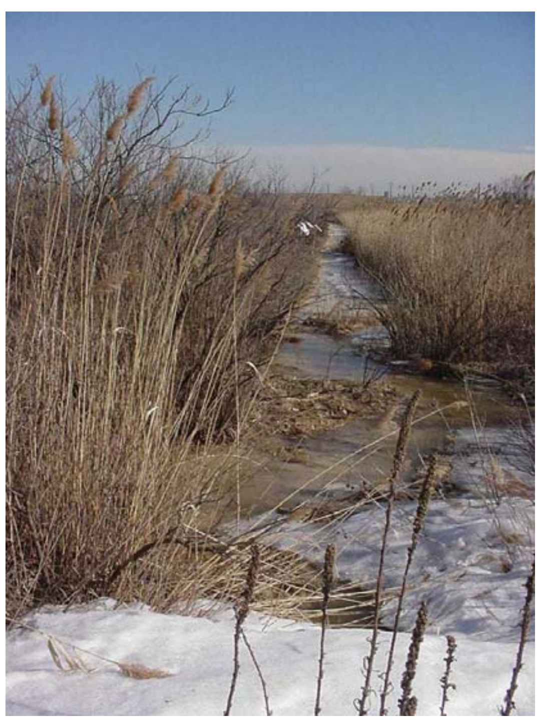
Photograph 1:  Broken bricks and glass on the Standard Chlorine site

Photograph 2:  Example of dilapidated building on the Standard Chlorine site

Photograph 3:  The former distillation building in the lagoon system area

Photograph 4:  The lagoon system

Photograph 5:  Trench with standing water located inside the fenced area surrounding the lagoon system



Photograph 6:  The southern drainage ditch

Photograph 7: Sea boxes containing dioxin-contaminated asbestos among other process wastes

Photograph 8: The office building on the western portion of the Standard Chlorine site


Photograph 9: Entrance to the Standard Chlorine site

Photograph 10: Example of broken windows on the Standard Chlorine site

Photograph 11:  The north outfall adjacent to the former Diamond Shamrock site

Photograph 12:  Trailer storage on the former Diamond Shamrock property

Photograph 13: Storm drain located on the driveway shared between Standard Chlorine and the former Diamond Shamrock site

Photograph 14: Standing water as observed in the shared driveway

# APPENDIX C

**Toxicological Characteristics of Chemicals of Concern**

The toxicological summaries provided below are based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html) and the NJDHSS Right to Know Program (http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm#D). Health effects are summarized in this section for some of the chemicals of concern found most frequently above CVs in the Hackensack River surface water and sediment.

The health effects described in the toxicological summaries are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium is present in the environment in several different forms, which are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds. The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Chromium enters the air, water, and soil mostly in the chromium(III) and chromium(VI) forms. In air, chromium compounds are present mostly as fine dust particles which eventually settle over land and water. Chromium can strongly attach to soil and only a small amount can dissolve in water and move deeper in the soil to underground water. Fish do not accumulate much chromium in their bodies from water.

Breathing high levels of chromium(VI) can cause irritation to the nose, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium(VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium(VI) compounds can cause skin ulcers. Allergic reactions consisting of severe redness and swelling of the skin have been noted.

Several studies have shown that chromium(VI) compounds can increase the risk of lung cancer. Animal studies have also shown an increased risk of cancer. The World Health Organization (WHO) has determined that chromium(VI) is a human carcinogen. The US Department of Health and Human Services (DHHS) has determined that certain chromium(VI) compounds are known to cause cancer in humans. The EPA has determined that chromium(VI) in air is a human carcinogen.

It is unknown if exposure to chromium will result in birth defects or other developmental effects in people. Birth defects have been observed in animals exposed to chromium(VI). It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

1,2-Dichlorobenzene

1,2-Dichlorobenzene is a colorless to pale yellow liquid with a pleasant odor. It is used as a fumigant, solvent, chemical intermediate, and insecticide.

1,2-Dichlorobenzene can affect you when breathed in and by passing through your skin. Contact can irritate and burn the skin and eyes. Skin allergy may develop. Exposure can cause headache, nausea, and irritation of the nose and throat. Higher exposure can cause you to become dizzy and lightheaded and to pass out. Long-term exposure may damage the blood cells. 1,2-Dichlorobenzene may damage the liver, kidneys and lungs, and affect the nervous system. This chemical has not been adequately evaluated to determine whether brain or other nerve damage could occur with repeated exposure. However, many solvents and other petroleum-based chemicals have been shown to cause such damage. Effects may include reduced memory and concentration, personality changes (withdrawal, irritability), fatigue, sleep disturbances, reduced coordination, and/or effects on nerves supplying internal organs (autonomic nerves) and/or nerves to the arms and legs (weakness, "pins and needles").

There is a suggested association between exposure to 1,2-Dichlorobenzene and leukemia. According to the information presently available to the New Jersey Department of Health and Senior Services, 1,2-Dichlorobenzene has been tested and has not been shown to affect reproduction.

1,3-Dichlorobenzene

1,3-Dichlorobenzene is a colorless liquid. It is used as a fumigant, an insecticide, and as a chemical intermediate. Acute (short-term) health effects may occur immediately or shortly after exposure to 1,3-Dichlorobenzene. Breathing 1,3-Dichlorobenzene can irritate the nose and throat causing coughing and wheezing. Contact can cause skin and eye irritation and burns. Exposure to 1,3-Dichlorobenzene can cause headache, drowsiness, nausea, vomiting diarrhea and abdominal cramps. 1,3-Dichlorobenzene may damage the red blood cells leading to low blood count (anemia). Chronic (long-term) health effects can occur at some time after exposure to 1,3-Dichlorobenzene and can last for months or years. There is no evidence that 1,3-Dichlorobenzene causes cancer in animals. This is based on test results presently available to the New Jersey Department of Health and Senior Services from published studies. According to the information presently available to the New Jersey Department of Health and Senior Services, 1,3-Dichlorobenzene has not been tested for its ability to affect reproduction. Other chronic effects include skin allergies. If an allergy develops, very low future exposure can cause itching and a skin rash. 1,3-Dichlorobenzene may affect the liver and kidneys.

1,4-Dichlorobenzene

1,4-Dichlorobenzene is a chemical used to control moths, molds, and mildew, and to deodorize restrooms and waste containers. It is also called para-DCB or p-DCB. Other names include Paramoth, Para crystals, and Paracide reflecting its widespread use to kill moths. At room temperature, p-DCB is a white solid with a strong, pungent odor. When exposed to air, it slowly changes from a solid to a vapor. Most p-DCB in our environment comes from its use in moth repellent products and in toilet deodorizer blocks.

In air, it breaks down to harmless products in about a month. It does not dissolve easily in water. It is not easily broken down by soil organisms. It evaporates easily from water and soil, so most is found in the air. It is taken up and retained by plants and fish.

There is no evidence that moderate use of common household products that contain p-DCB will result in harmful effects to your health. Harmful effects, however, may occur from high exposures. Very high usage of p-DCB products in the home can result in dizziness, headaches, and liver problems. Some of the patients who developed these symptoms had been using the products for months or even years after they first began to feel ill.

Workers breathing high levels of p-DCB (1,000 times more than levels in deodorized rooms) have reported painful irritation of the nose and eyes. There are cases of people who have eaten p-DCB products regularly for months to years because of its sweet taste. These people had skin blotches and lower numbers of red blood cells.

The US Department of Health and Human Services (DHHS) has determined that p-DCB may reasonably be anticipated to be a carcinogen. There is no direct evidence that p-DCB can cause cancer in humans. However, animals given very high levels in water developed liver and kidney tumors.

There is very little information on how children react to p-DCB exposure, but children would probably show the same effects as adults. No studies in people or animals show that p-DCB crosses the placenta or can be found in fetal tissues. Based on other similar chemicals, it is possible that this could occur. There is no credible evidence that p-DCB causes birth defects. One study found dichlorobenzenes in breast milk, but p-DCB has not been specifically measured.

### 1,2,4-Trichlorobenzene

1,2,4-Trichlorobenzene is a colorless liquid with a pleasant odor. It is used in heat transfer fluids, as a dielectric fluid, and in making chemicals, insecticides and fungicides. Breathing 1,2,4-Trichlorobenzene can irritate the nose, throat and eyes. Acute (short-term) health effects may occur immediately or shortly after exposure to 1,2,4-Trichlorobenzene: Contact can irritate the skin. Prolonged contact may cause skin burns. Chronic (long-term) health effects can occur at some time after exposure to 1,2,4-Trichlorobenzene and can last for months or years. Repeated exposure may damage the liver and kidneys. According to the information presently available to the New Jersey Department of Health and Senior Services, 1,2,4-Trichlorobenzene has been tested and has not been shown to cause cancer in animals. 1,2,4-Trichlorobenzene has been tested and has not been shown to affect reproduction based on information presently available to the New Jersey Department of Health and Senior Services.

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.  These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd0pyrene, phenanthrene, and naphthalene

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

The US Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.  Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

2,3,7,8-TCDD (Dioxin)

2,3,7,8-TCDD belongs to a family of 75 chemically related compounds commonly known as chlorinated dioxins (CDD).  It is one of the most toxic of the CDDs and is the one most studied.  2,3,7,8-TCDD is odorless and the odors of the other CDDs are not known.

2,3,7,8-TCDD may be formed during the chlorine bleaching process at pulp and paper mills.  CDDs are also formed during chlorination by waste and drinking water treatment plants. They can occur as contaminants in the manufacture of certain organic chemicals.  CDDs are released into the air in emissions from municipal solid waste and industrial incinerators.

When released into the air, some CDDs may be transported long distances, even around the globe.  CDD concentrations may build up in the food chain, resulting in measurable levels in animals. Eating food, primarily meat, dairy products, and fish, makes up more than 90% of the intake of CDDs for the general population.

The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people.

In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects. The offspring of animals exposed to 2,3,7,8-TCDD during pregnancy often had severe birth defects including skeletal deformities, kidney defects, and weakened immune responses.

Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD. The World Health Organization (WHO) has determined that 2,3,7,8-TCDD is a human carcinogen. The US Department of Health and Human Services (DHHS) has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer. Very few studies have looked at the effects of CDDs on children. Chloracne has been seen in children exposed to high levels of CDDs. It is not known that CDDs affect the ability of people to have children or if it causes birth defects, but given the effects observed in animal studies, this cannot be ruled out.

PCB – Arochlor 1260

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the US by the trade name Arochlor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators.

PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs. Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The US Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The USEPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported. In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.